AUGUST 2008

CITY OF MANTECA

Antidegradation Analysis for Proposed Wastewater Quality Control Facility Discharge Modification

prepared by

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Acknowledgements

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Executive Summary

The City of Manteca (City) has requested the Central Valley Regional Water Quality Control Board (Regional Water Board) to increase the NPDES-permitted capacity of its Wastewater Quality Control Facility (WQCF) to 17.5 million gallons per day (MGD) average dry weather flow (ADWF) from the current permitted discharge capacity of 9.87 MGD (ADWF). The City requests the additional discharge capacity to accommodate planned community growth and development. The State's Porter-Cologne Water Quality Control Act requires that waters of the State be regulated so as to maintain the highest water quality that is reasonable. The State Water Resources Control Board's (State Water Board) Antidegradation Policy (Resolution 68-16) requires that the quality of existing high quality waters be maintained unless it has been demonstrated that any change will be consistent with the maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial uses, and will not result in water quality less than that prescribed in State policies. The policy also requires that dischargers proposing to increase their discharge to high quality waters employ best practicable treatment or control to assure the highest water quality that is reasonable. The Federal Antidegradation Policy requires that existing high quality waters be maintained unless a lowering of water quality is necessary to accommodate important economic and social development.

The purpose of this antidegradation analysis is to demonstrate that the requested increase in permitted capacity is consistent with the Porter-Cologne Act and State and federal antidegradation policies.

WATER QUALITY IMPACTS OF AN INCREASE IN PERMITTED CAPACITY

The wastewater treatment process upgrades recently completed as part of the WQCF Phase III expansion, including nitrification-denitrification, tertiary filtration, and ultraviolet (UV) disinfection facilities, allow the WQCF to discharge very high quality tertiary treated effluent to the San Joaquin River. The City proposes to discharge this same high quality effluent to the river at higher flowrates following Phase IV of the WQCF expansion which will increase the WQCF discharge capacity from the currently permitted 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The near-field and far-field water quality impact assessments presented in this analysis show that the proposed increase in WQCF discharge capacity to the San Joaquin River will generally have very minor impacts on the water quality of the San Joaquin River and Sacramento-San Joaquin Delta (Delta), with the exception of a near-field exceedance of the U.S. EPA chronic ambient water quality criterion (87 µg/L) for total aluminum (USEPA, 2002). The exceedance of the aluminum water quality objective in the receiving water is the result of the ambient levels of the parameter already exceeding standards upstream of the WQCF discharge. Because the WQCF effluent aluminum concentrations are considerably lower than the upstream levels, an increase in WQCF effluent discharge will slightly decrease total aluminum concentration in the San Joaquin River downstream of the discharge.

The City recently completed a Water Effects Ratio (WER) study (City of Manteca, 2007) to identify an appropriate site-specific water quality objective for aluminum in the San Joaquin River that is both sufficiently protective of aquatic life and identifies available assimilative capacity for aluminum in the river under which the WQCF can discharge its effluent. The study indicates that a WER of 22.7 in scientifically defendable. To this end, the next lowest water quality standard for aluminum (Title 22 Secondary Maximum Contaminant Level (MCL) of 200

μg/L) may be applicable to WQCF effluent. Title 22 Secondary MCLs are set to evaluate potable water that has received treatment, including filtration that generally removes the particulate materials from the water, leaving essentially only the dissolved fraction. However, Title 22 standards do not directly specify whether the total or dissolved phase should be considered. Applying Secondary MCLs directly to surface water warrants consideration in that only the dissolved fraction would ultimately pass through a drinking water treatment plant. While the California Department of Public Health (CDPH) has recently stated that application of Secondary MCLs as dissolved is sufficient to protect municipal and drinking water uses, it has been the Regional Water Board's policy to apply it as a total concentration objective to be protective of taste and odor for direct consumption of San Joaquin River water. Most importantly, an increase in WQCF permitted discharge capacity from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) does not negatively impact the San Joaquin River with regard to this parameter, and in fact will decrease total aluminum concentrations in the receiving water.

Effluent cooling facilities planned as part of the Phase IV expansion, will be designed to mitigate potential exceedances of the Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan; SWRCB, 1972) objectives. The cooling facilities will be operated according to a schedule determined by river flowrate and season as necessary to satisfy no non-negligible impacts on sensitive aquatic species based on the expert opinions of fisheries biologists and involved parties charged with determining the significance of the WQCF thermal plume to migrating salmonids and other resident fish species. The City is requesting an exception to Thermal Plan provisions limited to ambient conditions and seasons where thermal impacts will be negligible to sensitive aquatic species.

The Thermal Plan objectives are slightly exceeded between the currently permitted discharge of 8.11 MGD and 9.87 MGD (ADWF); however, an evaluation of the impacts of the thermal plume reveals that there are no significant impacts of the plume and a limited exception is being sought for the WQCF. Because the Thermal Plan objectives are exceeded, the characteristics of the WQCF plume need to be evaluated for the level of impact on aquatic life. If the plume is found not to impact the aquatic life within the San Joaquin River, then an exception to the Thermal Plan will be required. If the plume is determined to significantly impact aquatic life in the San Joaquin River, then the City is prepared to design, construct, install, and operate cooling facilities that cool treated effluent prior to its discharge into the San Joaquin River. The cooling facilities would be confirmed to perform at final design specifications prior to operation of the WQCF at the proposed expanded capacity.

Increasing the effluent flowrate to the requested ADWF of 17.5 MGD will increase the thermal plume, resulting in exceedance of both the 1 °F temperature differential over less than 25% of the cross section, and the 4 °F differential anywhere objectives in the Thermal Plan. Effluent cooling facilities planned as part of the Phase IV expansion, will be designed to mitigate potential exceedances of the Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan; SWRCB, 1972) objectives. The cooling facilities will be operated according to a schedule determined by river flowrate and season as necessary to satisfy no non-negligible impacts on sensitive aquatic species based on the expert opinions of fisheries biologists and involved parties charged with determining the significance of the WQCF thermal plume to migrating salmonids and other resident fish species. The City is requesting an exception to Thermal Plan provisions limited to

ambient conditions and seasons where thermal impacts will be negligible to sensitive aquatic species.

All other near- and far-field constituents considered in this report are expected to exhibit only slight to minor increases in concentration in the receiving water at well-mixed conditions downstream of the discharge at the proposed 17.5 MGD (ADWF) discharge capacity. With the exception of aluminum, median San Joaquin River concentrations of modeled constituents are not anticipated to exceed relevant water quality objectives, and on average are estimated to be present at concentrations well below these objectives.

COSTS AND BENEFITS OF ALTERNATIVES FOR MAINTAINING EXISTING WATER QUALITY

Maintaining existing water quality in the San Joaquin River and the Delta with an increase in WQCF discharge may be approached through effluent-to-land disposal or additional wastewater treatment by microfiltration and reverse osmosis (MF/RO). These alternatives each possess unique abilities to address water quality constituents of concern and each has distinct implementation benefits, liabilities, and costs. To maintain existing water quality and mass loading in the San Joaquin River from the time the WQCF reaches its current permitted capacity of 9.87 MGD (AWDF) through the proposed 17.5 MGD (ADWF) capacity, it is estimated that a maximum effluent-to-land disposal capacity of 8.0 MGD or a maximum MF/RO capacity of 7.3 MGD would be required. The implementation of either alternative would maintain WQCF effluent mass loading to the San Joaquin River at the currently permitted 9.87 MGD (ADWF) level, but the costs of implementing either alternative would be above and beyond the proposed project costs associated with increasing WQCF discharge capacity to 17.5 MGD (ADWF).

The first alternative, land application of secondary treated effluent would offset projected reductions in San Joaquin River water quality as a result of the proposed project, and would also provide an additional water supply source to the region. An 8.0 MGD effluent-to-land disposal operation would cost an estimated $28.5 million to construct and an additional $300,000 per year to operate. An economic impacts model estimates that these costs would have adverse socio-economic effects, including a loss of 17 jobs per year to the local economy for the 20-year life-cycle of the alternative control measure. Additionally, land application of secondary treated effluent would add salts (as measured by total dissolved solids (TDS)) to the groundwater basin underlying the application site(s). Addition of salts to groundwater at a concentration greater than the Title 22 Secondary MCL *recommended* level of 500 mg/L, or greater than ambient background quality, would produce an unfavorable environmental impact, especially in light of the existing, elevated salinity and boron levels found in Central Valley surface waters and groundwater. Effluent-to-land disposal also carries the risk of causing groundwater mounding in the area(s) of land application. A final unfavorable environmental impact of the effluent-to-land disposal alternative is an increase in energy consumption and greenhouse gas emissions due to the substantial power requirements of pumping effluent to storage ponds and then to land application sites.

Similar to the effluent-to-land disposal alternative, the implementation of MF/RO would offset estimated reductions in San Joaquin River water quality due to an increase in WQCF effluent discharged above the current permitted 9.87 MGD (ADWF) capacity. A 7.3 MGD MF/RO treatment facility would cost an estimated $93.5 million to construct and an additional $4.9 million per year to operate. An economic impacts model estimates that these costs would have

adverse socio-economic effects, including a loss of 78 jobs per year to the local economy for the 20-year life-cycle of the alternative control measure. Moreover, MF/RO treatment would produce adverse environmental impacts resulting from the concentration of toxic compounds, removal and transference of these toxic substances to various other media, brine and crystallized residuals disposal, and the substantial energy requirements of the process with their associated natural resource and air quality impacts.

PROPOSED PROJECT AND ADDITIONAL MEASURES

The proposed project is designed to minimize impacts on water quality while allowing for measured growth in the City and providing overall wastewater treatment system stability. In addition to the proposed project, the City continues to pursue other significant system improvements and source control efforts to ensure the highest discharge water quality and improve receiving water quality. The following projects will improve the WQCF's overall discharge water quality:

- Increased use of high quality surface water within the service area. The City's potable water supply is expected to improve in quality, with respect to electrical conductivity (EC), as compared to pre-August 2005 conditions due to the blending of surface water from the South County Water Supply Program with the City's groundwater. The blending of surface water with groundwater for the potable water supply has significantly decreased the EC measured in WQCF effluent when comparing pre- and post-August 2005 plant effluent measurements (LWA, 2006b).

- Recycled water use is part of the 2007 WQCF Master Plan. Construction of a backbone delivery network is proposed to deliver recycled water to the municipal golf course, regional softball complex, major commercial centers along State Route (SR) 120, and the largest community parks in South Manteca. Recycled water storage and pumping facilities have been constructed at the WQCF in conjunction with completion of the Schedule D project in 2007. A Title 22 Engineering Report has been processed with the California Department of Public Health for the initial set of reuse sites. The City continues to facilitate the use of recycled water produced at the WQCF.

CONSISTENCY WITH ANTIDEGRADATION POLICIES

The proposed project, a 7.63[1] MGD (ADWF) increase in WQCF discharge capacity with accompanying nitrification-denitrification, tertiary filtration, and UV disinfection treatment to treat the increased flow, is determined to comprise best practicable treatment or control and is consistent with federal and State antidegradation policies for the following reasons:

- The increase in permitted discharge capacity is necessary to accommodate important economic and social development in the City and surrounding communities, and is consistent with the City's General Plan. Failure to approve the increase, or alternatively requiring the City to implement control measures that would maintain existing water quality and mass emissions in the San Joaquin River, would have significant adverse

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[1] WQCF requested maximum discharge capacity of 17.5 MGD (ADWF) less existing NPDES-permitted discharge of 9.87 MGD (ADWF) results in a net requested increase in discharge capacity of 7.63 MGD (ADWF).

economic and social impacts on the City and surrounding communities and their citizens and businesses.

- The increase will not adversely affect existing or probable beneficial uses of the San Joaquin River, nor will it cause water quality to fall below applicable water quality objectives.

- The increase, while causing slight increases in downstream water quality concentrations for some constituents (biological oxygen demand (BOD), ammonia (October through May), dissolved arsenic, dissolved copper, total cyanide, methylene blue active substances (MBAS), nitrate, nitrite, total mercury, and EC), will produce slight decreases in downstream concentrations for others (total suspended solids (TSS), total aluminum, dissolved iron, and dissolved manganese). The proposed increase in discharge capacity is also projected to cause minor increases in downstream water quality concentrations for ammonia (June through September). Total aluminum currently exceeds its water quality objective in the San Joaquin River upstream of the WQCF outfall.

- The benefits of maintaining existing water quality and mass emissions for the constituents analyzed are not commensurate with the costs of additional treatment. The small decrease in quality with respect to the constituents considered in the analysis is unlikely to affect beneficial uses of the San Joaquin River.

- Based on the above, the requested increase in permitted capacity is consistent with federal and State antidegradation policies in that the lowering of water quality for several pollutants is necessary to accommodate important economic or social development, will not unreasonably affect beneficial uses, will not cause further exceedances of applicable water quality objectives, and is consistent with the maximum benefit to the people of the State.

- Based on the above, the requested increase in permitted capacity is consistent with the Porter-Cologne Act in that the resulting water quality will constitute the highest water quality that is reasonable, considering all demands placed on the waters, economic and social considerations, and other public interest factors.

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Introduction

PROJECT LOCATION AND BACKGROUND

The City of Manteca's Wastewater Quality Control Facility (WQCF) is located at the northern end of the San Joaquin Valley of Central California approximately 75 miles east of San Francisco and 55 miles south of Sacramento. The WQCF is located approximately 1.5 miles west of the City of Manteca (City) in southern San Joaquin County. The WQCF has expanded several times since operations began in 1959. From 1986 – 1988, a major expansion to the plant known as Phase I was constructed. The Phase I expansion project included the construction of secondary treatment facilities, anaerobic sludge digesters, sludge drying beds, a chlorine disinfection system, and an outfall to the San Joaquin River at the point latitude 37°, 46', 45" (deg, min, sec) and longitude 121°, 18', 00" (deg, min, sec). The WQCF outfall is sited approximately one mile upstream of the Mossdale Bridge which is located near the intersection of Interstate 5 and Highway 120. Design capacity of the plant following the Phase I project was 5.45 million gallons per day (MGD) average dry weather flow (ADWF). The Phase II expansion project constructed in 1992 and 1993 added a primary sedimentation basin, a secondary clarifier, and four sludge drying beds, increasing plant capacity to 6.95 MGD (ADWF).

In 1995, the City adopted a Wastewater Quality Control Facility Master Plan that identified Phase III improvements. The Phase III improvements included the construction of nitrification-denitrification facilities (increasing plant capacity from 6.95 MGD to 7.5 MGD (ADWF)), improved primary and secondary treatment facilities (increasing capacity from 7.5 MGD to 9.87 MGD (ADWF)), and solids handling, tertiary filtration and ultraviolet (UV) disinfection facilities (Nolte, 1995). The City has divided Phase III improvements into four schedules: A, B, C, and D.

Schedule A, B, and D improvements have been completed. Schedule A improvements included two new aeration basins, three modified secondary clarifier sludge collection mechanisms, two new centrifugal blowers, and a skid-mounted centrifugal dewatering system. Schedule B improvements included a new influent pump station, two aerated grit tanks, three primary sedimentation basins, five aeration basins, two secondary clarifiers, an odor control biofilter, and an expanded laboratory and administration building. Schedule D improvements included a secondary effluent equalization pond, a filter feed pump station, coagulation and flocculation facilities, tertiary filters, a chemical storage and handling facility, a UV disinfection system, an effluent pumping station, two odor control biofilters, recycled water pumping stations, a groundwater well, and a construction truck recycled water filling station. Schedule D improvements allow for the off-line storage and timed discharge of treated effluent to the San Joaquin River.

Construction of Schedule C improvements commenced in October 2007 and includes a sludge control building, a mechanical dewatering facility, and a shop maintenance building. Schedule C improvements are anticipated to be constructed and operational by October 2008. It is anticipated that Phase III improvements would satisfy the City's wastewater treatment capacity demands for the next 5 – 10 years depending on the build-out rate of proposed development.

Beyond the Phase III expansion, the City has identified the need to plan for future facilities to accommodate growth contained in its General Plan (City of Manteca, 2003), which plans growth out until 2023. As such, the City has prepared its Wastewater Quality Control Facility Master

Plan Update (Nolte, 2007). This master plan update considers the necessary treatment facilities to accommodate up to 27 MGD (ADWF), which will accommodate growth through 2023. The proposed project is the first of two construction phases identified in the WQCF Master Plan Update. The proposed project is known as the Phase IV expansion and involves an increase in WQCF capacity from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). Phase V would further increase capacity from 17.5 MGD (ADWF) to 27 MGD (ADWF); Phase V expansion is not considered in the current analysis as it is not scheduled to begin until the year 2020, beyond the next NPDES permit cycle. By constructing the proposed master plan facilities in phases, the City can control the rate of facility expansion to coincide with actual growth rates that may be slower or faster than projected.

PROJECT DESCRIPTION

During the Phase IV expansion, the City is proposing to increase the permitted wastewater discharge capacity of the WQCF from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) and construct new trunk sewers to accommodate growth contained in the City's General Plan (City of Manteca, 2003). The project includes treatment plant improvements for both river and land-based wastewater effluent disposal based on current and future probable water quality discharge requirements and projected flows.

The proposed project would be initiated no sooner than 2010 and would include construction of treatment facilities to achieve compliance with water quality objectives and permit requirements. The City proposes to accommodate the increase in capacity by using the City's long-term effluent disposal strategy that includes land application, urban landscape irrigation, and river discharge. The proposed project would also include the incremental construction of three new trunk sewers and improvements to the existing collection system.

PURPOSE OF REPORT

The purpose of this report is to document the City's antidegradation analysis for a projected discharge increase in permitted discharge capacity to the San Joaquin River from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The information contained in this analysis is intended to provide the Central Valley Regional Water Quality Control Board (Regional Water Board) with the information needed to determine whether to certify that the proposed permitted discharge increase is consistent with State and federal antidegradation policies.

APPROACH TO ANALYSIS

The antidegradation analysis described in this report follows the guidance provided by the State Water Resources Control Board (State Water Board) regarding the implementation of the antidegradation policy in NPDES permits (APU 90-004). Pursuant to the guidelines, this analysis follows the provisions for a 'complete analysis' and evaluates whether changes in water quality resulting from the proposed capacity increase are 'consistent with maximum benefit to the people of the State, will not unreasonably affect uses and will not cause water quality to be less than water quality objectives and that the discharge provides protection for existing in-stream uses and water quality necessary to protect those uses.'

The complete analysis is comprised of two main components: (1) a comparison of the projected receiving water quality to the water quality objectives and/or criteria used to protect designated

beneficial uses, and (2) a socio-economic impacts analysis to establish the balance between the proposed action and the public interest.

The following items are addressed in the complete antidegradation analysis:

1. Determine if there are measurable water quality impacts and, if so, whether beneficial uses are impacted. This is accomplished, in part, by comparing estimated resulting receiving water quality to the water quality objectives and/or criteria used to protect designated beneficial uses.

2. Evaluate incremental loading increases and their impacts.

3. Evaluate the costs and benefits of reducing or eliminating the load increase.

4. Balance the proposed project against the public interest.

These items are addressed in the following sections of this report:

- Regulatory requirements

- Applicable water quality objectives and commonly used water quality criteria

- Environmental setting

- Assessment of water quality impacts

- Assessment of socio-economic considerations

- Consistency with antidegradation policies

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Regulatory Requirements

FEDERAL AND STATE ANTIDEGRADATION POLICIES

Antidegradation policies have been adopted at both the federal and state level. These policies are intended to protect existing water quality.

The federal policy, originally adopted in 1975, is expressed as a regulation in 40 CFR 131.12. The federal regulation requires that "water quality shall be maintained and protected". More specifically, the federal regulation requires the states to develop and adopt a statewide antidegradation policy and identify the methods for implementing such policy. The antidegradation policy and implementation methods shall, at a minimum, be consistent with ensuring that existing water uses and the level of water quality necessary to protect these uses shall be maintained and protected. Where the quality of water is better than that necessary to support beneficial uses, measures shall be taken to ensure that water quality is maintained and protected unless the State finds that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the water body is located.

The State policy to maintain high quality waters in California was adopted in 1968 as a resolution of the State Water Board (Resolution No. 68-16). The state policy requires that changes in water quality not unreasonably affect beneficial uses. The state policy sets forth the following requirements:

1. *Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies.*

2. *Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.*

STATE GUIDANCE ON NPDES PERMITTING AND ANTIDEGRADATION

In addition to the federal and state policies, the State Water Board issued guidance (APU 90-04) to all Regional Water Boards regarding the implementation of antidegradation policies in NPDES permits. The guidance addresses both the State and federal antidegradation policies in the issuance of NPDES permits. By using this guidance, a Regional Water Board can better determine if the proposed discharge is consistent with the intent and purpose of the state and federal antidegradation policies. APU 90-04 provides the Regional Water Board with guidance on the appropriate level of analysis that may be necessary, distinguishing between the need for a simple antidegradation analysis and a complete antidegradation analysis. If it is determined that a simple analysis is not appropriate, the State Water Board guidance describes a more rigorous level of analysis, called a "complete" analysis. A primary focus of the "complete" analysis is the

determination of whether, and the degree to which, water quality is lowered. This determination greatly influences the level of analysis required and the level of scrutiny applied to the "balancing" test – i.e. whether the facility is necessary to accommodate important economic and social development, and whether a water quality change is consistent with maximum benefit to the people of the State.

Key requirements of a complete analysis are as follows:

- Determination of whether the project will produce minor effects which will not result in a significant reduction of water quality; and

- Determination of whether proposed load increases are substantial.

Factors to be considered in determining whether a project is necessary to accommodate important economic or social development and is consistent with maximum public benefit are:

- Past, present and probable beneficial uses.

- Economic costs to maintain water quality compared to the benefits.

- Environmental aspects of the proposed discharge.

- Consideration of feasible alternative control measures which might reduce, eliminate or compensate for negative impacts of the project.

The City has followed the procedures outlined in the guidance for conducting a complete antidegradation analysis to provide the Regional Water Board with the maximum amount of information available.

Applicable Water Quality Standards

BENEFICIAL USES

The Water Quality Control Plan for the Sacramento-San Joaquin River Basins (Basin Plan), originally adopted by the Central Valley Regional Water Board in 1975 and amended regularly, contains descriptions of the legal, technical, and programmatic bases for water quality regulation in the region. The Basin Plan describes the beneficial uses of major surface waters and their tributaries and the corresponding water quality objectives put into effect to protect these beneficial uses. In addition to being subject to the provisions contained in the Basin Plan for the Sacramento-San Joaquin River Basins, the discharges from the WQCF occur within the legal boundaries of the Sacramento-San Joaquin Delta (Delta) and are therefore subject to the water quality standards contained in the Water Quality Control Plan for the Sacramento-San Joaquin Bay-Delta, as adopted by the State Water Board.

Table 1 presents the existing beneficial uses for the Delta, the applicable water body for the planned WQCF discharge to the San Joaquin River.

Table 1: Beneficial Uses Designated for the Sacramento-San Joaquin River Delta

Beneficial Uses for Surface Water defined in the Basin Plan	Designated for Sacramento-San Joaquin Delta
Municipal and Domestic Supply (MUN)	Yes
Agricultural Supply: Irrigation (AGR)	Yes
Agricultural Supply: Stock Watering (AGR)	Yes
Industrial Process Supply (PROC)	Yes
Industrial Service Supply (IND)	Yes
Industrial Power Supply (POW)	No
Water Contact Recreation: Contact Recreation (REC 1)	Yes
Water Contact Recreation: Canoeing and Rafting (REC 1)	No
Non-Contact Water Recreation (REC 2)	Yes
Warm Freshwater Habitat (WARM)	Yes
Cold Freshwater Habitat (COLD)	Yes
Migration of Aquatic Organisms: Warm Water (MIGR)	Yes
Migration of Aquatic Organisms: Cold Water (MIGR)	Yes
Fish Spawning, Warm Water (SPWN)	Yes
Fish Spawning, Cold Water (SPWN)	No
Wildlife Habitat (WILD)	Yes
Navigation (NAV)	Yes

Source: Water Quality Control Plan for the Sacramento River Basin and San Joaquin River Basin, Fourth Edition, Revised August 2006 (CVRWQCB, 2006b)

WATER QUALITY OBJECTIVES/WATER QUALITY CRITERIA

To protect the designated beneficial uses, the Regional Water Board applies water quality objectives contained in the Basin Plan, the California Toxics Rule (CTR), and other sets of water quality criteria to the receiving water; the San Joaquin River, specifically, and the Delta in general. The Regional Water Board uses these objectives and criteria to determine if the City's discharge will cause or contribute to a violation of an applicable water quality standard. **Table 2** presents the most conservative water quality criteria used to protect the most sensitive beneficial uses that apply to the San Joaquin River and Delta for select constituents. Constituents included in **Table 2** are those for which the WQCF has adopted effluent limits, as well as dissolved oxygen (DO), due to the Total Maximum Daily Load (TMDL) for DO in the Stockton Deep Water Ship Channel (DWSC), and temperature (due to the narrative temperature limitations contained in the Thermal Plan that are applicable to WQCF effluent discharged to the San Joaquin River). Water quality objectives for toxic constituents come from the CTR, as promulgated by the U.S. EPA (40 CFR §131.38). The hardness-based objective for total cyanide listed in the CTR was calculated using a hardness value (172 mg/L) measured during the low fall flows of October 2002 in the San Joaquin River at WQCF R-1; 2002 is a water year classified as "dry" by the California Department of Water Resources.

Table 2: Applicable Water Quality Objectives and/or Criteria for the San Joaquin River and Sacramento-San Joaquin Delta

| Classification | Constituent | Most Stringent Water Quality Objective or Criteria | | Reference |
		Value	Unit	
Bacteriological	Fecal Coliform	200/100 mL	MPN	Basin Plan
Conventional	Biochemical Oxygen Demand (BOD)	N/A	N/A	N/A
	Chlorine Residual	0.011	mg/L	Draft TRC Policy of CA[1]
	Dissolved Oxygen	5	mg/L	Basin Plan
	Electrical Conductivity (April – August)	700	μmhos/cm	Basin Plan
	Electrical Conductivity (September – March)	1000	μmhos/cm	Basin Plan
	Methylene Blue Active Substances (MBAS)	500	μg/L	Title 22 MCL (secondary MCL)[2]
	Oil and Grease	Narrative	--	Basin Plan
	pH	6.5 ≤ pH ≤ 8.5	std. units	Basin Plan
	Settleable Solids	Narrative	--	Basin Plan
	Temperature	Narrative	°F	Thermal Plan[3]
	Total Suspended Solids (TSS)	Narrative	--	Basin Plan
	Turbidity	20% increase	NTU	Basin Plan

Table 2: Applicable Water Quality Objectives and/or Criteria for the San Joaquin River and Sacramento-San Joaquin Delta (Continued)

Classification	Constituent	Most Stringent Water Quality Objective or Criteria		Reference
		Value	Unit	
Metal	Aluminum, Total	87	μg/L	U.S. EPA National Recommended WQ Criterion (Chronic)[4]
	Arsenic, Dissolved	10	μg/L	Basin Plan, Table III-1
	Copper, Dissolved	10	μg/L	Basin Plan, Table III-1
	Cyanide, Total	5.2	μg/L	California Toxics Rule (Freshwater, Chronic)
	Iron, Dissolved	300	μg/L	Basin Plan, Table III-1
	Manganese, Dissolved	50	μg/L	Basin Plan, Table III-1
	Mercury, Total	0.050	μg/L	California Toxics Rule (Human Health, Water & Organisms)
Nutrient	Ammonia as N (June – September)	0.62	mg/L	U.S. EPA 1999 Update of Ambient Water Quality Criteria for Ammonia (30-day average)[5]
	Ammonia as N (October – May)	5.62	mg/L	U.S. EPA 1999 Update of Ambient Water Quality Criteria for Ammonia (1-hour average)[6]
	Nitrate as N	10	mg/L	Title 22 MCL (Primary)/ Basin Plan[2]
	Nitrite as N	1	mg/L	Title 22 MCL (Primary)/ Basin Plan[2]
Organic	2,4,6-Trichlorophenol	2.1	μg/L	California Toxics Rule (Human Health, Water & Organisms)
	Bis(2-ethylhexyl)phthalate	1.8	μg/L	California Toxics Rule (Human Health, Water & Organisms)
	Bromodichloromethane	0.56	μg/L	California Toxics Rule (Human Health, Water & Organisms)
	Dibromochloromethane	0.41	μg/L	California Toxics Rule (Human Health, Water & Organisms)

(1) Draft Total Residual Chlorine and Chlorine-Produced Oxidants Policy of California, June 2006.
(2) Incorporated into the Basin Plan by reference (CVRWQCB, 2006b).
(3) California Thermal Plan (SWRCB, 1972).
(4) Numeric criterion used to interpret narrative water quality objective.
(5) Numeric criterion used to interpret narrative water quality objective based on a pH of 8.4 std. units and a temperature of 26 °C; cited in NPDES No. CA0081558 (CVRWQCB, 2004).
(6) Numeric criterion used to interpret narrative water quality objective based on a pH of 8 std. units; cited in NPDES No. CA0081558 (CVRWQCB, 2004).

303(D) LISTINGS

Section 303(d) of the Clean Water Act requires states to develop lists of water bodies (or segments of water bodies) that will not attain water quality standards after implementation of minimum required levels of treatment by point-source dischargers (i.e., municipalities and industries). Section 303(d) requires states to develop a TMDL for each of the listed pollutant and water body combinations for which there is impairment. A TMDL is the amount of loading that the water body can receive and still meet water quality standards for that pollutant. The TMDL must include an allocation of allowable loadings for both point and non-point sources, with consideration of background loadings and a margin of safety. NPDES permit limitations for listed pollutants must be consistent with allocations identified in adopted TMDLs.

The U.S. EPA partially approved California's 2006 303(d) list on November 30, 2006, and gave full and final approval to the list on June 28, 2007. In contrast to the four Delta sub-regions included in the 2002 303(d) list, the 2006 303(d) list divides the Delta into eight sub-regions, each possessing a set of pollutants/stressors that have been identified as preventing the sub-region from meeting water quality standards. Of the eight new sub-regions contained in the Delta, six are likely to receive a minor fraction of WQCF effluent over the course of any given water year depending on flow conditions and hydraulic operations of the Delta. These six sub-regions include the Central Delta, Eastern Delta, Export Area, Southern Delta, Stockton Ship Channel, and the Western Delta. **Table 3** lists the constituents identified in the 2006 303(d) list for the six Delta sub-regions, and **Table 4** presents potential sources and proposed TMDL completion dates for these listed constituents.

Table 3: 2006 Clean Water Act Section 303(d) Listed Constituents as they pertain to Sacramento-San Joaquin Delta Waterways

Pollutant/Stressor	Delta Waterways					
	Central Portion	Eastern Portion	Export Area	Southern Portion	Stockton Ship Channel	Western Portion
Chlorpyrifos	X		X	X		
DDT	X	X	X	X	X	X
Diazinon	X		X	X		
Dioxin					X[1]	
Electrical Conductivity			X	X		X
Exotic Species	X	X	X	X	X	X
Furan Compounds					X[1]	
Group A Pesticides	X	X	X	X	X	X
Mercury	X	X	X	X	X	X
Pathogens					X[1]	
PCBs					X[1]	
Unknown Toxicity	X	X	X	X	X	X

(1) This listing was previously under Stockton Turning Basin, upper (Port Turning Basin). In order to consolidate listings for same areas, all listings for Stockton Turning Basin on the 2002 303(d) list are now included under the Delta Waterways (Stockton Ship Channel) sub-region.

Table 4: Potential Sources and Proposed TMDL Completion Dates of Pollutants/Stressors for Select Delta Waterways contained in 2006 Clean Water Act Section 303(d) List

Pollutant/Stressor	Potential Sources	Proposed TMDL Completion
Chlorpyrifos	Agriculture, Urban Runoff/Storm Sewer	2019
DDT	Agriculture	2011
Diazinon	Agriculture, Urban Runoff/Storm Sewer	2019
Dioxin	Point Source	2019
Electrical Conductivity	Agriculture	2019
Exotic Species	Source Unknown	2019
Furan Compounds	Contaminated Sediments	2019
Group A Pesticides	Agriculture	2011
Mercury	Resource Extraction (abandoned mines)	2006
Pathogens	Urban Runoff/Storm Sewer, Recreational and Tourism Activities (non-boating)	2008
PCBs	Point Source	2019
Unknown Toxicity	Source Unknown	2019

NPDES PERMIT REQUIREMENTS

The WQCF currently operates and discharges treated effluent to the San Joaquin River under the requirements of NPDES permit No. CA0081558 (Order No. R5-2004-0028), issued by the Central Valley Regional Water Quality Control Board in March 2004. The permit includes three sets of effluent limitations for discharge to the San Joaquin River based on the design treatment capacity of the WQCF as it undergoes its scheduled improvements. The permit contains effluent limitations for design treatment capacities of 6.95, 8.11, and 9.87 MGD (ADWF).

In April 2005, the City requested that the effluent limitations for bromodichloromethane and dibromochloromethane be modified based upon current treatment plant performance. The WCQF had historically operated in a non-nitrifying or partially nitrifying mode, which typically produced an effluent with elevated levels of ammonia. In November 2003, the treatment process was converted to full nitrification mode to reduce ammonia. Without ammonia in the effluent, organochlorines are formed, which are less effective disinfectants than chloramines. Consequently, more chlorine is required for disinfection, thereby increasing concentrations of disinfection byproducts, including bromodichloromethane and dibromochloromethane. As such, it was necessary for the City's NPDES permit to be amended by Resolution No. R5-2005-0110 (amended WDR Order No. R5-2004-0028). This amendment introduced increases to the effluent limitations for bromodichloromethane and dibromochloromethane based on dilution credits recalculated using new effluent data collected while the WQCF was operating in full nitrification mode. These effluent limitations are also listed for design treatment capacities of 6.95, 8.11, and 9.87 MGD (ADWF).

In order to eliminate the disinfection byproducts, the City completed replacement of the chlorine disinfection system with UV-light disinfection in September 2007 as part of the Schedule D WQCF improvements. Although limited, initial effluent monitoring results following the UV

installation have been encouraging with visible reductions in effluent levels of chlorine-disinfection byproducts.

Table 5 presents the effluent limits (at a 9.87 MGD (ADWF) design treatment capacity) contained in the City's NPDES permit as adopted by the Regional Water Board in Order No. R5-2004-0028 and as amended by Order No. R5-2005-0110. Only effluent limits at the 9.87 MGD (ADWF) design treatment capacity are presented because the WQCF is currently permitted to operate up to 9.87 MGD (ADWF) and this antidegradation analysis considers water quality impacts of a WQCF permitted wastewater discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). Effluent limitations for ammonia as nitrogen, copper, cyanide, bis(2-ethylhexyl)phthalate, bromodichloromethane, dibromochloromethane, and 2,4,6-trichlorophenol were calculated with applicable dilution credit.

Table 5: Adopted Effluent Limits for WQCF's Discharge to the San Joaquin River at a 9.87 MGD (ADWF) Design Treatment Capacity

Constituent	Units	Monthly Average	Weekly Average	1-Hour Average	Daily Maximum
BOD[1]	mg/L	10[2]	20[2]	---	30[2]
TSS	mg/L	10[2]	20[2]	---	30[2]
Total Coliform	MPN/100 mL	---	2.2[3]	---	23/240[4]
Turbidity	NTU	---	---	2[5]	5/10[6]
Settleable Solids	ml/L	0.1	---	---	0.2
Chlorine Residual	mg/L	---	0.01[7]	0.02	---
Oil and Grease	mg/L	10	---	---	15
Aluminum[8]	μg/L	71	---	---	140
Electrical Conductivity[9]	μmhos/cm	1000	---	---	---
pH	pH units	---	---	---	6.5 to 8
Ammonia as N (June – September)	mg/L	2.1	---	---	4.4
Ammonia as N (October – May)	mg/L	2.8	---	---	5.6
Arsenic	μg/L	10	---	---	---
Copper	μg/L	7.9	---	---	10.4
Cyanide	μg/L	3.7	---	---	10
Iron	μg/L	300	---	---	---
Manganese	μg/L	50	---	---	---
MBAS	μg/L	500	---	---	---
Nitrate as N	mg/L	10	---	---	---
Nitrite as N	mg/L	1	---	---	---
Bis(2-ethylhexyl)-phthalate	μg/L	22	---	---	44
Bromodichloromethane[10]	μg/L	30	---	---	47
Dibromochloromethane[10]	μg/L	7	---	---	16
Mercury	lbs/year	0.69	---	---	---
2,4,6-Trichlorophenol	μg/L	34	---	---	69

(1) 5-day, 20°C biochemical oxygen demand (BOD).
(2) To be ascertained by a 24-hour composite sample.
(3) Weekly median.
(4) Does not exceed 23 in more than one sample in any 30-day period. No sample shall exceed 240.
(5) Does not exceed an average of 2 NTU within a 24-hour period.
(6) Does not exceed 5 NTU more than 5 percent of the time within a 24-hour period and 10 NTU at any time.
(7) Expressed as 4-day average.
(8) Compliance with effluent limitations for aluminum specified in Order No. R5-2004-0028 shall be determined using acid soluble methods of measurement. The Discharger may conduct a water effect ratio study to develop a site-specific objective, and upon adoption and approval of a Basin Plan amendment, the permit may be reopened and the aluminum limitation reconsidered.
(9) Effluent limitation adopted by State Water Resources Control Board in Order WQ 2005-0005.
(10) Effluent limitation adopted by Regional Water Board in Resolution No. R5-20050110.

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Environmental Setting

SACRAMENTO-SAN JOAQUIN DELTA AND SAN JOAQUIN RIVER BASIN

The Delta forms the lowest part of the Central Valley, lying between the Sacramento and San Joaquin rivers and extending inland from the confluence of the two rivers to Sacramento and Stockton. The Delta is roughly bordered by the cities of Sacramento, Stockton, Tracy, and Pittsburg. Other cities within the Delta include Manteca, Lathrop, Antioch, Brentwood, Rio Vista, and Isleton. There are also about 14-unincorporated towns and communities in the Delta. The area receives runoff from over 45 percent of the State's land area including flows from 19 tributaries: the Sacramento, McCloud, Butte, Feather, Yuba, Bear, American, Merced, San Joaquin, Mokelumne, Cosumnes, Stanislaus, Tuolumne, Chowchilla, Fresno, Kings, Cache, Putah, and Calaveras rivers. The Delta is within the jurisdiction of six counties (Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo) and covers approximately 1,500 square miles interlaced with hundreds of miles of waterways (DWR, 1993). The Delta is delineated by a legal boundary that includes the areas that historically were intertidal, along with supratidal portions of the floodplains of the Sacramento and San Joaquin rivers. Today's legal Delta extends between the upper extent of tidal effect (near the City of Sacramento on the Sacramento River and Vernalis on the San Joaquin River) and Chipps Island on the west (CALFED, 1999).

The 290-mile-long San Joaquin Valley occupies the southern half of the Central Valley and has an average width of 130 miles. It covers approximately 32,000 square miles, or one-fifth of the surface area of California. The San Joaquin River Basin is bounded on the west by the Coast Ranges and on the east by the Sierra Nevada mountain range. The Tulare Lake Basin to the south is normally considered a separate drainage basin, but has contributed occasional flood flows and subsurface flows to the San Joaquin River during wet years (DWR, 1995). The San Joaquin River itself is 330 miles in length and drains a watershed area of 13,540 square miles (CSLC, 1993). It flows west from the Sierra Nevada, turns sharply north at the center of the valley floor, and flows north through the valley into the Delta. San Joaquin River monthly average flow ranges from 400 to 1,500 cubic feet per second (cfs) in dry years, 1,500 to 3,500 cfs in normal years, and up to 20,000 cfs to 40,000 cfs in wet years (CALFED, 1999). Major tributaries draining the Sierra Nevada and flowing into the San Joaquin River include the Stanislaus, Tuolumne, Merced, and Fresno rivers (see **Figure 1**). The San Joaquin River flows through portions of Fresno, Madera, Merced, Stanislaus, San Joaquin, Contra Costa, and Sacramento counties. The WQCF is currently permitted to discharge secondary treated effluent to the San Joaquin River approximately one mile upstream of the Mossdale Bridge which is located near the intersection of Interstate 5 and Highway 120.
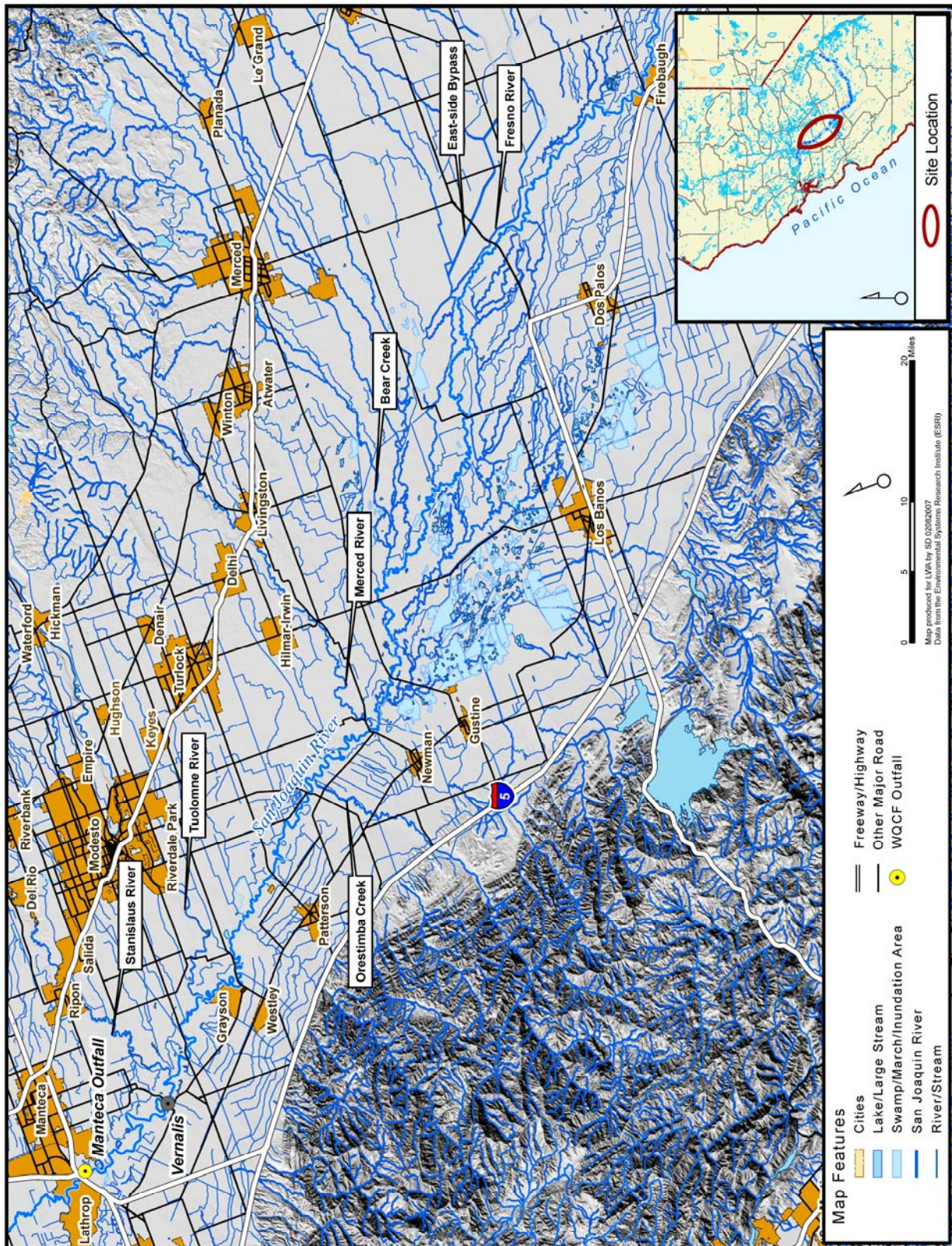
Figure 1: Lower San Joaquin River and Eastside Tributaries

SAN JOAQUIN RIVER BASIN HYDROLOGY

San Joaquin River Basin hydrology is predominantly influenced by tributary inflows, agricultural diversions and return flows, and tidal flows. For the purpose of this antidegradation analysis, the Lower San Joaquin River can be divided into two main sections based on the presence or absence of tidal flows. The Lower San Joaquin River from Mendota Pool to Vernalis receives inflow from a variety of sources including east-side tributaries, dominated by reservoir releases; west-side tributaries, dominated by agricultural return flows; groundwater recharge; and discharges from wetlands and publicly owned wastewater treatment facilities. Diversions can remove a significant amount of San Joaquin River flow, especially during periods of below normal rainfall. The Lower San Joaquin River is not typically affected by tidal flows, being sufficiently upstream of the Pacific Ocean's tidal influence.

The second main section of the Lower San Joaquin River is the tidally influenced reach from Vernalis to its confluence with the Sacramento River near Collinsville. Major tributary inputs to this section are provided by the Cosumnes and Mokelumne rivers where their commingled flows enter the central Delta near Webb Tract. Significant non-tributary inflows are provided from irrigation return flows that are pumped from adjacent agricultural lands into the San Joaquin River. The major diversion of San Joaquin River water occurs at the junction of Old River, where, depending on Delta hydraulics, up to 50% of San Joaquin flows may be diverted to the south Delta (Quinn and Tulloch, 2002).

An understanding of the hydrology and hydrochemistry of the San Joaquin River can be gained through a review of the relative flow contributions made by east-side tributaries, west-side tributaries, and other inflows. As shown in **Figure 1**, the major east-side tributaries are the Merced, Tuolumne, and Stanislaus rivers which join the Lower San Joaquin River upstream of Vernalis. There are also three minor east-side tributaries in the Basin, including Bear Creek, the east-side Bypass, and the Mariposa Bypass. There are nine significant streams and conveyances that drain the west-side of the San Joaquin Basin and are tributary to the San Joaquin River. These tributaries include Panoche-Silver Creek, San Luis Drain, Salt Slough, Mud Slough, Spanish Grant Drain, Orestimba Creek, Hospital Creek, Ingram Creek, and Del Puerto Creek. Many of these streams are ephemeral, conveying rainfall runoff during the winter season and agricultural return flows during the summer months. The San Luis Drain is a concrete-lined conveyance that once formed part of a Valley Master Drain system providing drainage for the entire west-side of the Basin. The Drain presently serves five agricultural water districts and conveys subsurface drainage water into Mud Slough, six miles upstream of the confluence with the San Joaquin River. Due to the Drain's importance to the hydrology of the San Joaquin River, it is considered a west-side tributary (Quinn and Tulloch, 2002).

A comparison of flow and TDS (salts) inputs into the San Joaquin River by a variety of sources is provided in **Table 6**. During the period 1985 – 1994, annual average flows from all east-side tributaries collectively accounted for 70% of the flow measured in the San Joaquin River at Vernalis. In contrast, west-side tributaries contributed 4% of the flow measured at Vernalis. While east-side tributaries contributed approximately 17.5 times the flow of west-side tributaries, the estimated TDS loading of the east-side tributaries was about three quarters of that provided by west-side tributaries. This difference in TDS loading can be attributed to the fact that snow-melt comprises a large proportion of east-side flow volume, while return flows from agriculture and wetlands dominate west-side hydrology. Tributary contributions notwithstanding, all other

sources collectively contributed 26% of total flow and 63% of estimated TDS loading in the San Joaquin River at Vernalis. The largest non-tributary TDS loadings were made by groundwater (191,000 tons) and surface water return flows (150,000 tons). Municipal and industrial sources contributed minor discharge volumes (1%) and TDS loads (2-3%), similar in magnitude to contributions from subsurface return flows (Quinn and Tulloch, 2002).

Table 6: Sources and Percent Contributions of Flow and TDS in the San Joaquin River at Vernalis (1985 – 1994)

Source	Discharge[1] (acre-feet x 1000)	Percent Contribution	TDS Load[2] (tons x 1000)	Percent Contribution
East-side tributaries	1,323	70	148	16
Groundwater	90	5	191	20
West-side tributaries	68	4	201	21
Grassland wetlands	60	3	74	8
Groundwater inflow	11	1	77	8
West-side surface returns	70	4	57	6
Subsurface return flows (main stem SJR)	11	1	25	3
Surface return flows (main stem SJR)	250	13	150	16
Municipal and Industrial	15	1	14	2
Total	1,899	100%	938	100%

Source: Quinn and Tulloch, 2002.
(1) 10-year mean annual flow calculated from 1985 – 1994.
(2) 10-year mean annual load calculated from 1985 – 1994.

LAND USE

Land use in the Delta is dominated by agriculture (about 538,000 acres). Open water covers approximately 60,000 acres, while urban and commercial property account for about 64,000 acres of developed land (DWR, 2005). The remainder of the region currently consists of undeveloped public lands and open space. Of the portions of six counties that encompass the legal Delta, San Joaquin County comprises the majority of land included within the legal Delta boundary. Within San Joaquin County, approximately 77% of the total county acreage is used for agriculture and grazing, followed by medium-density residential (7%), low-density residential (4%), and industrial land uses (3%) (U.S. Fish and Wildlife Service et al., 2006).

The valley portion of the San Joaquin River Basin shows a similar land use pattern as the Delta, with the area predominantly comprised of farmland. Growing urban centers exist in Stockton, Tracy, Modesto, Manteca, Lathrop, and Merced. Agriculture is the major economic and land use activity in the San Joaquin River Basin. The San Joaquin Valley is recognized as one of the most important agricultural regions in California, with approximately 2 million acres of irrigated cropland and an annual agricultural output valued at more than $4.9 billion in the year 2000. Non-agricultural commerce in the region is generated by a variety of industries including food processing, chemical production, lumber and wood products, glass, textiles, paper, machinery, fabricated metal products, and various other commodities (DWR, 2005).

Assessment of Water Quality Impacts

The WQCF and collection system serves commercial and residential uses within the City of Manteca, a portion of the City of Lathrop, and one frozen food packager (Eckert Cold Storage). The WQCF is permitted for treatment and discharge of 9.87 MGD (ADWF) of wastewater, with 8.42 MGD (or 85.3 percent) capacity allocated to the City of Manteca and 1.45 MGD (or 14.7 percent) allocated to the City of Lathrop. The City leases 150 acres of land from Dutra Farms (Assessor's parcel Nos. 241-320-01 and 241-320-02) for land application of treated wastewater. Land disposal of treated effluent is maximized by discharging effluent at agronomic rates seasonally to these leased parcels, as well as to existing City-owned property (210 acres). Excess flow of treated municipal wastewater is discharged via a side-bank outfall to the San Joaquin River approximately one mile upstream of the Interstate 5 Mossdale Bridge at the point latitude 37°, 46', 45" (deg, min, sec) and longitude 121°, 18', 00" (deg, min, sec).

The WQCF current capacity of 9.87 MGD (ADWF) is anticipated to support the City's wastewater needs for approximately 5 to 10 years. The existing WQCF outfall to the San Joaquin River will reach capacity following completion of the Phase III Expansion Project. Any expansion beyond a capacity of 9.87 MGD (ADWF) will require the construction of a second outfall pipeline.

The near-field water quality impacts assessment evaluates the effects of increasing WQCF discharge, from the permitted 9.87 MGD (ADWF) to a proposed 17.5 MGD (ADWF) effluent flowrate. Near-field effects on San Joaquin River water quality will occur between the point of discharge and WQCF monitoring location R-3 (approximately 1-mile downstream of the City's discharge) where advanced treated effluent and ambient river water are well-mixed. Near-field water quality impacts are estimated using (1) projected WQCF effluent quality following Phase III expansion; (2) ambient river concentrations calculated from dry/below normal water years, where possible; (3) current permitted and proposed future WQCF effluent flowrates; and (4) average late summer/early fall San Joaquin River flows observed during historic critical and dry water years. Estimated water quality conditions are then compared to existing water quality objectives or often used criteria to assess the impact of the proposed WQCF increased discharge on San Joaquin River water quality. San Joaquin River monitoring locations providing data used in the near-field water quality impacts analysis are presented in **Figure 2**.

The far-field water quality impacts assessment evaluates the effects of increasing WQCF discharge, from the permitted 9.87 MGD (ADWF) to a proposed 17.5 MGD (ADWF) effluent flowrate, on specific Delta locations where surface water is diverted for eventual use as drinking water and in the DWSC. Far-field water quality impacts are estimated using (1) historic WQCF effluent quality, (2) projected WQCF effluent quality following Phase III expansion, (3) current permitted and proposed future WQCF effluent flowrates; and (4) modeled percent contribution of WQCF effluent at select Delta locations under representative critical and dry/below normal water years. Estimated far-field water quality impacts are then evaluated as the change in concentration of a parameter at a Delta location of interest due to an increase in WQCF effluent flowrate from the permitted 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF). The Delta monitoring locations for which far-field water quality impacts were modeled are shown in **Figure 3**.
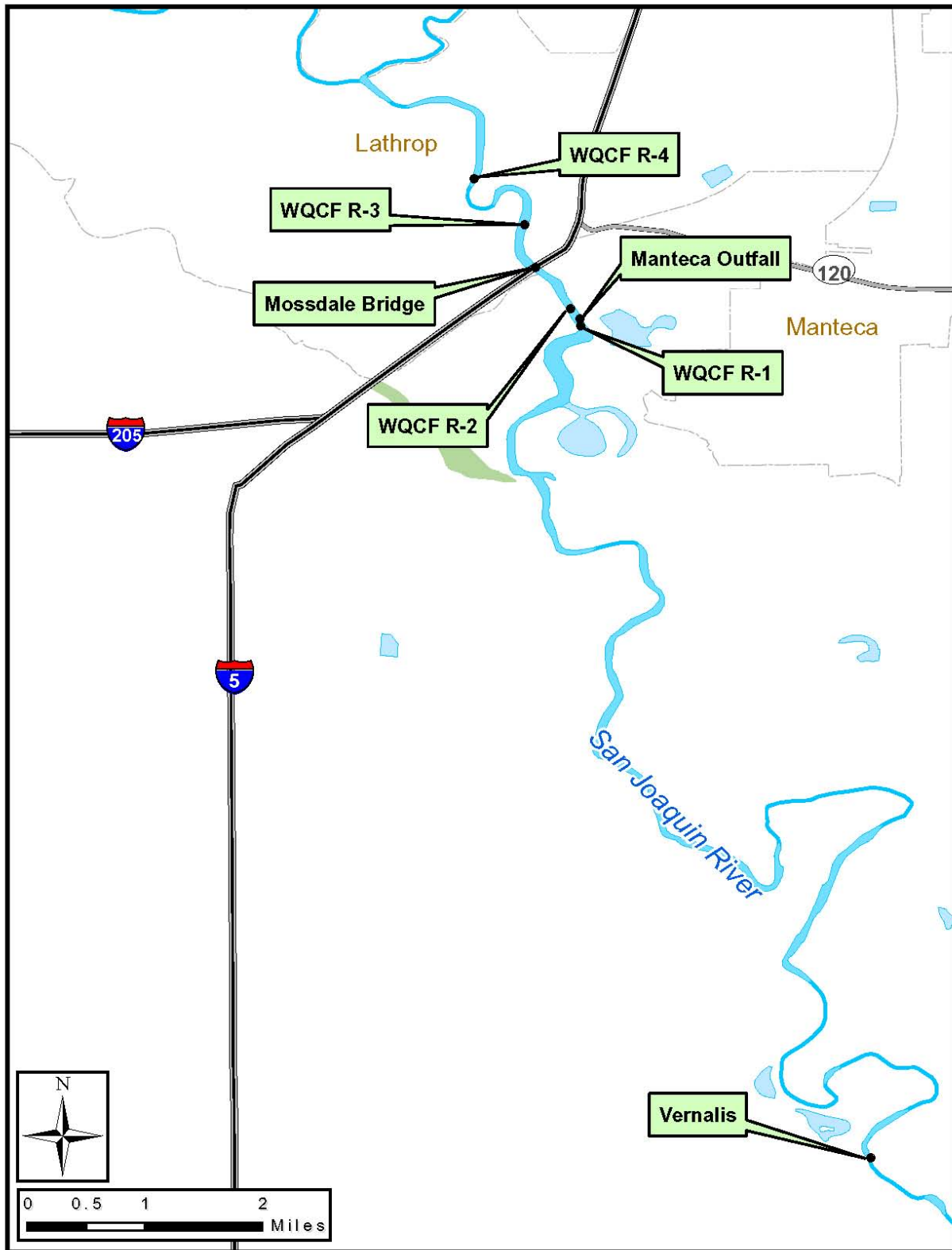
Figure 2: City of Manteca WQCF Outfall and San Joaquin River Monitoring Locations providing data for Near-Field Water Quality Impacts Analysis
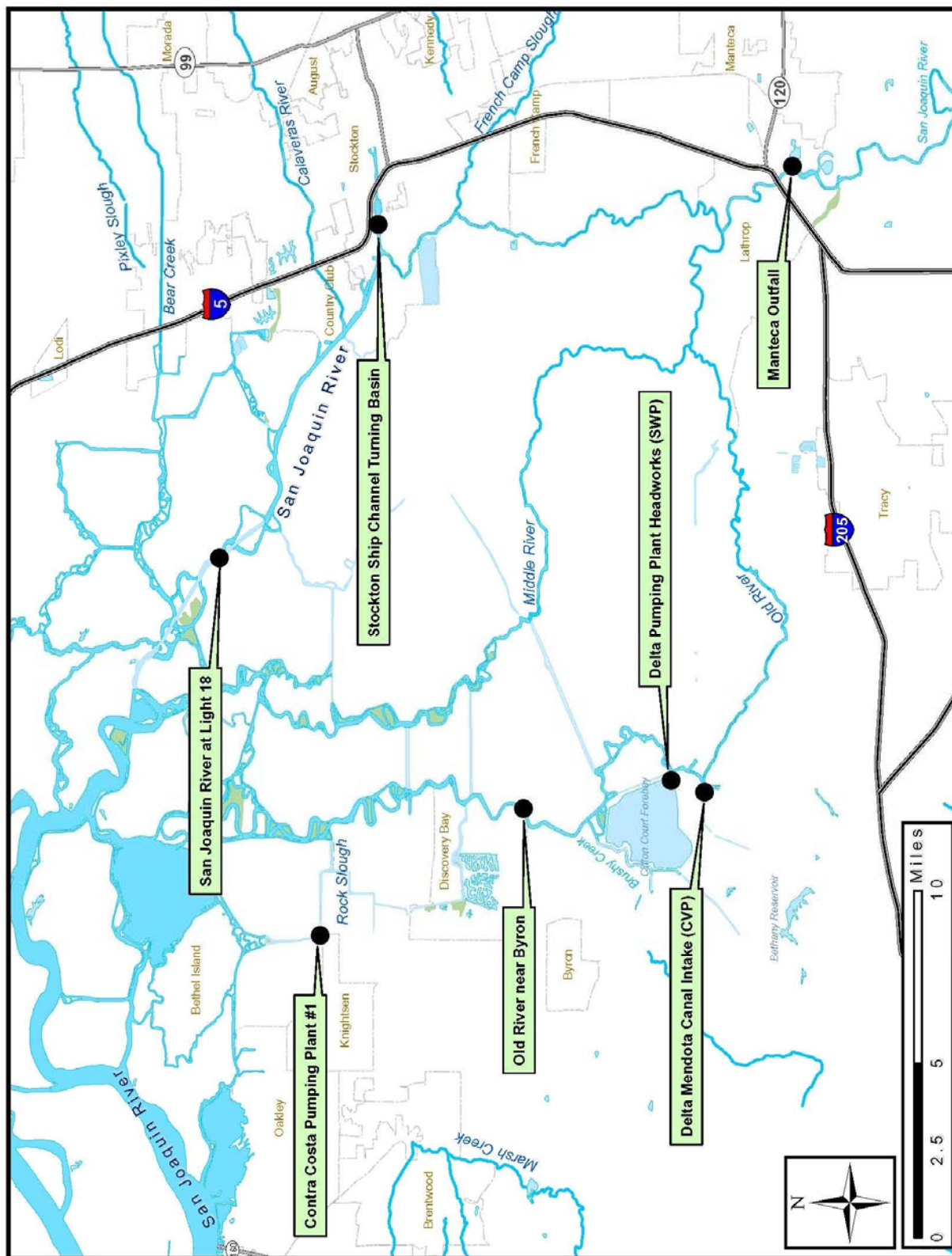
Figure 3: Sacramento-San Joaquin Delta Monitoring Locations evaluated for Far-Field Water Quality Impacts Analysis

SELECTION OF WATER QUALITY CONSTITUENTS

Water quality constituents were selected for quantitative near- and far-field analyses based on availability of adequate detected data in effluent and one or more of the following conditions:

1. WQCF received an effluent limitation for a particular constituent in Order No. R5-2004-0028,

2. Constituent was identified as a pollutant/stressor on the proposed 2006 Clean Water Act Section 303(d) list for select Delta waterways,

3. Constituent for which an adopted TMDL exists downstream of WQCF discharge, and

4. Constituent is an historic pollutant of concern in the Delta

Thirty-three water quality parameters were initially identified for evaluation based on the four criteria listed above. Eighteen parameters were ultimately selected for near-field and/or far-field analysis (see constituents in bold typeface presented in **Table 7**) based on availability of data and detection of constituent in WQCF effluent.

Table 7: Water Quality Constituents Identified for Near-Field and Far-Field Analyses

Constituent	Monitoring Location	Data Source(s)	Selected for Analysis
Biochemical Oxygen Demand (BOD)	SJR at Mossdale Bridge	DWR-MWQI	**Near-Field**
Total Suspended Solids (TSS)	WQCF R-1	Special studies monitoring data	**Near-Field**
Total Coliform	WQCF R-1	WQCF self-monitoring	No, non-conservative parameter[1]
Turbidity	WQCF R-1	WQCF self-monitoring	No, non-conservative parameter[1]
Settleable Solids	---	No data available	No
Chlorine Residual	WQCF R-1	WQCF self-monitoring	No, non-conservative parameter[1]
Oil and Grease	---	No data available	No
Aluminum, Total	WQCF R-1	13267 monitoring data, Self-monitoring data	**Near-Field**
Electrical Conductivity (EC)	WQCF R-1	13267 monitoring data, Self-monitoring data	**Near-Field**
	Multiple Delta locations	DWR-MWQI, DO Study-Stockton, DO Study-UOP, Stockton RWCF self-monitoring	**Far-Field**
Dissolved Organic Carbon (DOC)	Multiple Delta locations	DWR-MWQI, DO Study-Stockton, DO Study-DWR	**Far-Field**

Table 7: Water Quality Constituents Identified for Near-Field and Far-Field Analyses (Continued)

Constituent	Monitoring Location	Data Source(s)	Selected for Analysis
Dissolved Oxygen (DO)	Stockton Ship Channel	Regression model[2]	**Far-Field**
Ammonia as Nitrogen	WQCF R-1	13267 monitoring data, Self-monitoring data	**Near-Field**
Arsenic, Dissolved	WQCF R-1	13267 monitoring data	**Near-Field**
Copper, Dissolved	WQCF R-1	13267 monitoring data	**Near-Field**
Cyanide, Total	WQCF R-1	13267 monitoring data	**Near-Field**
Iron, Dissolved	WQCF R-1	Special studies monitoring data	**Near-Field**
Manganese, Dissolved	WQCF R-1	Special studies monitoring data	**Near-Field**
Methylene Blue Active Substances (MBAS)	WQCF R-1	13267 monitoring data	**Near-Field**
Nitrate as Nitrogen	WQCF R-1	13267 monitoring data	**Near-Field**
	Multiple Delta locations	DWR-MWQI	**Far-Field**
Nitrite as Nitrogen	WQCF R-1	13267 monitoring data	**Near-Field**
Bis(2-ethylhexyl)phthalate	WQCF R-1	Self-monitoring data	No, insufficient detected data
Bromodichloromethane	WQCF R-1	13267 monitoring data, Self-monitoring data	No, new UV disinfection process will bring effluent concentration of parameter below the level of detection
Dibromochloromethane	WQCF R-1	13267 monitoring data, Self-monitoring data	No, new UV disinfection process will bring effluent concentration of parameter below the level of detection
Mercury	WQCF R-1	13267 monitoring data, Self-monitoring data	**Near-Field**
2,4,6-Trichlorophenol	WQCF R-1	Self-monitoring data	No, insufficient detected data
Temperature	SJR transects between WQCF R-1 and WQCF R-2, inclusive	Self-monitoring data, Thermal Plan Exception Study data	**Near-Field**
Chlorpyrifos	---	13267 monitoring data	No, constituent non-detect in effluent
DDT	---	13267 monitoring data	No, constituent non-detect in effluent

Table 7: Water Quality Constituents Identified for Near-Field and Far-Field Analyses (Continued)

Constituent	Monitoring Location	Data Source(s)	Selected for Analysis
Diazinon	---	13267 monitoring data	No, constituent non-detect in effluent
Dioxin	---	No data available	No
Furan Compounds	---	No data available	No
Group A Pesticides	---	13267 monitoring data	No, constituent non-detect in effluent
PCBs	---	13267 monitoring data	No, constituent non-detect in effluent
Whole Effluent Toxicity	---	Self-monitoring data	**Near-Field**

(1) Constituent is considered a non-conservative parameter and inappropriate for the calculation of blended effluent-river concentrations in the near-field.
(2) Regression model for change in Stockton Ship Channel DO is extended version of model utilized in Draft EIR for Manteca WQCF Phase III/IV Expansion (EDAW, 2000)

Data Sources

The near- and far-field analyses conducted for the current water quality impacts assessment require a great deal of high quality data collected by the WQCF and various monitoring programs that collect ambient surface water quality data in the Delta. The various monitoring programs and monitoring locations providing the surface water quality data that were used in the near- and far-field analyses, as well as the time periods covered by these data are presented in **Table 8**.

Table 8: Sources of Surface Water Quality Data used in Near-Field and Far-Field Analyses

Data Source and Monitoring Program	Monitoring Location(s)	Monitoring Date Range(s)
Self-monitoring data: City of Manteca WQCF NPDES self-monitoring program	WQCF R-1	Apr. 2004 – Sept. 2004 (dry) Oct. 2005 – June 2006 (wet)
	Final Effluent Sampler (point of whole effluent toxicity sample collection)	July 2006 – Dec. 2007
13267 monitoring data: City of Manteca WQCF monitoring data collected pursuant to California Water Code §12367	WQCF R-1	Jan. 2002 – Jan. 2003 (dry)
Special studies monitoring data: City of Manteca WQCF monitoring data collected to determine reasonable potential for exceedance of dissolved metals objectives	WQCF R-1	Nov. 2005 – July 2006 (wet)
Thermal Plan Exception Study: City of Manteca WQCF monitoring data collected in support of the City's Thermal Plan Exception Analysis	SJR at Mossdale Bridge	Apr., Sept., Dec. 2002 (dry)

Table 8: Sources of Surface Water Quality Data used in Near-Field and Far-Field Analyses (Continued)

Data Source and Monitoring Program	Monitoring Location(s)	Monitoring Date Range(s)
DWR-MWQI: California Department of Water Resource Municipal Water Quality Investigations Program	SJR at Mossdale Bridge, Contra Costa Pumping Plant #1[1], Old River near Byron, Delta Pumping Plant Headworks, Delta Mendota Canal Intake at Lindemann Road	Oct. 1989 – Sept. 1994 (crit) Oct. 2000 – Sept. 2004 (dry)
DO Study-DWR: California Department of Water Resources data collected as part of San Joaquin River Dissolved Oxygen Study	Stockton Ship Channel Turning Basin	Oct. 2000 – Oct. 2001(dry)
DO Study-Stockton: City of Stockton data collected as part of San Joaquin River Dissolved Oxygen Study	Stockton Ship Channel Turning Basin, SJR at RWCF-R8[2]	Oct. 2000 – Sept. 2001(dry)
DO Study-UOP: University of the Pacific data collected as part of San Joaquin River Dissolved Oxygen Study	Stockton Ship Channel Turning Basin	June 2001 – Oct. 2001 (dry)
Stockton RWCF self-monitoring: City of Stockton Regional Wastewater Control Facility NPDES self-monitoring program	SJR at RWCF-R8[2]	Jan. 2004 – Sept. 2004 (dry)

"crit" – Data were collected during a critical water year; "dry" – Data were collected during a dry/below normal water year; "wet" – Data were collected during a wet water year.
(1) Contra Costa Pumping Plant #1 is also known as Contra Costa Water District Intake at Rock Slough.
(2) SJR at RWCF-R8 is also known as San Joaquin River at Navigation Light 18.

Data Quality Screening

Data from the water quality monitoring programs/studies shown in **Table 8** were selected for the present analysis because they meet the qualitative objectives of comparability and representativeness. Comparability of data can be defined as the similarity of data generated by different monitoring programs. This objective is evaluated primarily by comparing the sampling methods and analytical procedures used among various monitoring programs. Comparisons of data sets collected by the above-listed monitoring programs for a certain parameter at or near a particular location during a specific time period reveal a considerable degree of comparability. Representativeness of data can be defined as the degree to which the environmental data generated by a monitoring program accurately and precisely represent actual environmental conditions. This objective is addressed by the overall design of the monitoring program. Specifically, representativeness is evaluated by the selection of appropriate locations, times, frequencies of sampling, methods, and detection limits for each environmental parameter measured by a monitoring program, as well as the maintenance of the integrity of a sample after its collection and its overall evaluation by a rigorous QA/QC program. Finally, data were selected for near- and far-field water quality impacts assessments that possess detection limits that are sufficiently low to allow for comparison to relevant water quality objectives.

Depending on the monitoring site under consideration, data from a particular monitoring program typically acted as the primary data source for that monitoring site. The monitoring

program defined as the primary data source for a site was the program possessing the longest monitoring history at the particular location. If data from the primary data source were not available for a particular parameter at a particular site, then data from a secondary and/or tertiary data source were used. In an effort to compile as large a data set as possible for a particular parameter at a particular monitoring site, data from more than one monitoring program were often combined when appropriate to provide an extended data set. These secondary and tertiary data sources acted to "fill in" data gaps that exist in the primary program's monitoring record at a particular location. So as not to unfairly weigh certain sample collection dates by including more than one data point (coming from multiple monitoring programs) for any single calendar date, data from non-primary monitoring programs were omitted from the data set used for statistical analysis. For example, on the occasion that a particular monitoring location possessed three DO measurements taken on the same date, only a single DO measurement was included in the final data set. The single DO measurement chosen for analysis was taken from the monitoring program acting as the primary data source for the site. Excluding the other two DO measurements avoided the skewing of the statistical analysis since most monitoring dates were only represented by a single environmental measurement from a single monitoring program. Data were also excluded from use where analyte detection, analytical method, and detection limit were not documented sufficiently in a monitoring program's original raw data set.

Water Year Hydrologic Classification

Data for the 18 water quality parameters measured at selected sites in the project area (see **Table 7**) were compiled and summary statistics calculated to provide historic surface water quality information for two different water year types: critical years and dry/below normal years. Even though dry and below normal water years are distinct hydrologic classifications under the California Department of Water Resources hydrologic classification scheme (see **Figure 4**), they are grouped together in the current analysis as a "dry/below normal" water year type due to the grouping of data required to produce as large a water quality data set as possible. The analysis of water quality data for two distinct water year hydrologic classifications – critical and dry/below normal – provides information upon which to estimate future water quality conditions in the project area under the widely variable hydrologic conditions experienced in California's Central Valley. Critical and dry/below normal water years represent worse case conditions for most parameters as they relate to the impact of WQCF discharge on Delta water quality as compared to impacts measured during a wet or above normal water year. The current near- and far-field water quality impacts assessments were designed to estimate the incremental change in water quality within the project area with an increase in WQCF effluent flowrate from the current permitted 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF). The greatest incremental change in surface water quality conditions in the San Joaquin River and Delta would likely occur when WQCF effluent is discharged to a system with comparatively lower ambient pollutant concentrations and diminished flows such as those observed during critical and dry/below normal water years.

Using California Department of Water Resources water year hydrologic classifications for the San Joaquin Valley (see **Figure 4**), water quality data collected during specific water years were selected to determine baseline surface water quality in the project area during critical and dry/below normal water years. **Table 9** lists the water year designations and relevant time periods for the years 1990 through 2007. With regard to the constituents selected for near-field impact assessments in the project area (see **Table 7**), only San Joaquin River water quality data

from dry/below normal water years were available for analysis. Data from dry/below normal water years reflect different water quality conditions in the Delta relative to conditions observed during wet or above normal water years. San Joaquin River water quality and flow conditions characteristic of dry/below normal water years are expected to reflect future San Joaquin River conditions during rainfall-limited time periods due to the actions set forth in the Revised Water Right Decision 1641 (SWRCB, 2000) and the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (2006 Bay-Delta Plan; SWRCB, 2006).

The 2006 Bay-Delta Plan sets forth flow objectives to control declines in aquatic resources – namely, fisheries – experienced in the Bay-Delta Estuary in recent decades, in addition to providing upstream- and within-Delta management strategies for the protection of beneficial uses that involve salinity, water project operations, and DO. San Joaquin River at Vernalis flow objectives contained in the 2006 Bay-Delta Plan require spring and fall flows in the river to support spring out-migration and fall spawning of salmonids, respectively. Information gathered by parties during the limited-term Revised Water Rights Decision 1641 (in effect through 2010) will allow the State Water Board to further review Vernalis flow objectives in terms of timing and magnitude during a future review of the 2006 Bay-Delta Plan. Irrespective of final numeric flow objectives for the San Joaquin River at Vernalis that may be set forth in a future Bay-Delta Plan, future flow objectives will provide flows similar to or greater than those observed during dry water years, and not typical of those historically experienced during critical water years, as a means of protecting the aquatic life and water supply beneficial uses of the Bay-Delta Estuary.

Table 9: Hydrologic Classification of Years 1990 through 2007 by Water Year Type

Water Year Type	Water Year (Oct. 1 – Sept. 30)
Critical	1990
	1991
	1992
	1994
	2007
Dry	2001
	2002
	2004
Below Normal	2003
Above Normal	1999
	2000
Wet	1993
	1995
	1996
	1997
	1998
	2005
	2006

San Joaquin Valley Water Year Hydrologic Classification: 1990-2007
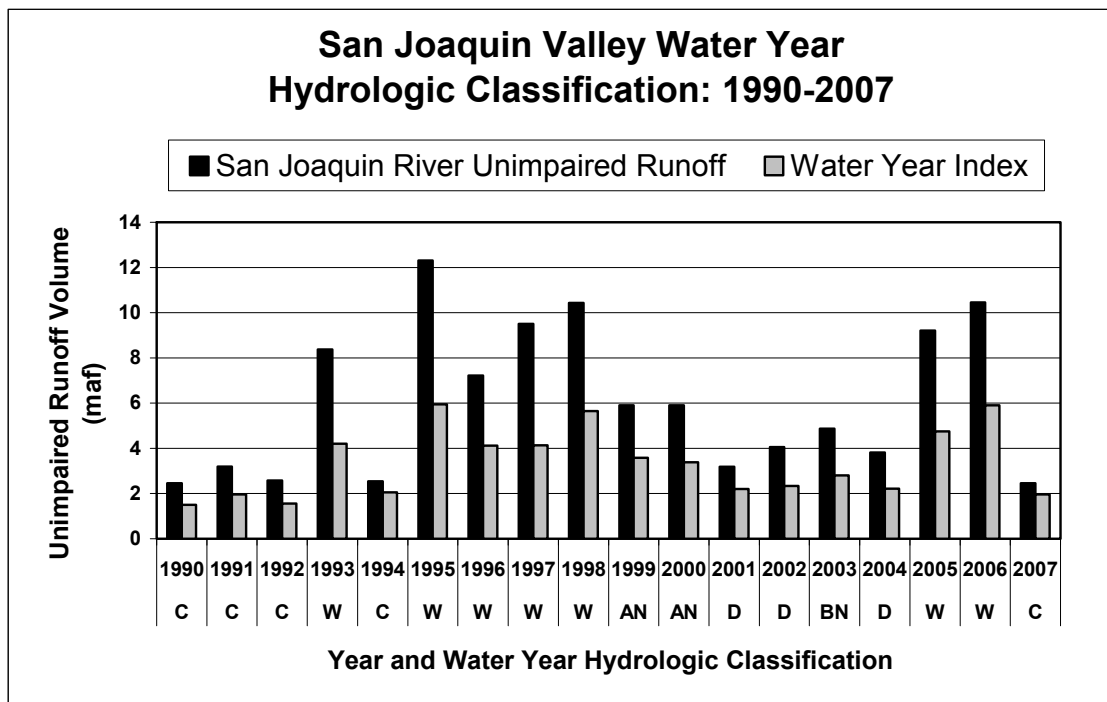
Notes:

1. The data presented above were generated by the California Department of Water Resources (see http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST). These indices have been used operationally by DWR for planning and managing of water supplies since 1995, and are defined in SWRCB Decision 1641 (see http://www.waterrights.ca.gov/baydelta/d1641.htm).

2. A water year extends from Oct 1 - Sep 30.

3. Unimpaired runoff represents the natural water production of a river basin, unaltered by upstream diversions, storage, or export of water to or import of water from other basins.

4. San Joaquin River Runoff is the sum of Stanislaus River inflow to New Melones Lake, Tuolumne River inflow to New Don Pedro Reservoir, Merced River inflow to Lake McClure, and San Joaquin River inflow to Millerton Lake.

5. San Joaquin Valley Water Year Index = 0.6 * Current Apr-Jul Runoff in (maf) + 0.2 * Current Oct-Mar Runoff in (maf) + 0.2 * Previous Water Year's Index [if the Previous Water Year's Index exceeds 4.5, then 4.5 is used).

6. San Joaquin Valley Water Year Hydrologic Classification:

Year Type:	Water Year Index:
W = Wet Year	Equal to or greater than 3.8
AN = Above Normal	Greater than 3.1, and less than 3.8
BN = Below Normal	Greater than 2.5, and equal to or less than 3.1
D = Dry	Greater than 2.1, and equal to or less than 2.5
C = Critical	Equal to or less than 2.1

Figure 4: San Joaquin Valley Unimpaired Runoff and Water Year Classification: 1990 – 2007

Data collected during both critical and dry/below normal water years at far-field Delta monitoring locations were available for use in the far-field impacts assessment. However, these ambient Delta water quality data sets are often limited and inconsistent or patchy in terms of the suite of constituents evaluated at any given monitoring site, and thus collectively produce a geographical and chronological mosaic of Delta water quality conditions that provides an incomplete picture of far-field water quality impacts due to an increase in WQCF discharge. The only parameters with sufficient data to produce a reasonable depiction of far-field impacts during critical and dry/below normal water years due to an increase in WQCF discharge are electrical conductivity (EC), dissolved organic carbon (DOC), and nitrate (as nitrogen). EC, DOC, and nitrate (as nitrogen) are general indicators of water quality and are important parameters used by water purveyors to assess treatment requirements of raw water.

NEAR-FIELD METHODOLOGY

The near-field effects on water quality of the current permitted WQCF design capacity (9.87 MGD (ADWF)) and the proposed WQCF design capacity (17.5 MGD (ADWF)) are compared using a mass balance equation. Using projected effluent quality and available ambient San Joaquin River water quality (measured at R-1 and the Interstate 5 Mossdale Bridge) and flow data (measured at Vernalis), a mass balance was performed to assess the effect of WQCF discharge on downstream concentrations of pollutants with an increase in effluent flowrate. Based on recent hydrodynamic modeling (RMA, 2006), WQCF effluent and San Joaquin River water are considered well-mixed approximately 1-mile downstream of the WQCF outfall, near the WQCF R-3 self-monitoring site. The instantaneous effluent flowrates from timed discharge operation are not evaluated in the analysis because impacts on receiving water are being evaluated sufficiently far downstream of the discharge, effectively evaluating the average daily effluent flowrate on the receiving water conditions (RMA, 2006). The two near-field WQCF discharge scenarios for which ambient San Joaquin River concentrations downstream of the WQCF discharge are estimated include:

- 9.87 MGD (ADWF) – currently permitted treatment capacity (effluent characteristics following completion of Phase III Schedule D improvements)

- 17.5 MGD (ADWF) – proposed intermediate design flow at end of Phase IV WQCF expansion

Near-field analyses were conducted for the 16 parameters specified in **Table 7**. Data used in the near-field analysis came from the various monitoring programs presented in **Table 8**. It should be noted that limited receiving water data were available for all parameters considered for near-field impact assessments. The parameter concentrations used in the assessment of the near-field water quality impacts are presented in **Table 10**. These values represent the projected effluent quality following full stabilization of the treatment improvements recently installed as part of the WQCF Phase III Expansion Project (Nolte, 2007).

Table 10: Projected WQCF Effluent Quality after Phase III Expansion

Constituent	Units	Projected Effluent Quality[1]
Biochemical Oxygen Demand (BOD)	mg/L	7
Total Suspended Solids (TSS)	mg/L	<10
Total Coliform	MPN/100 mL	<2.2
Turbidity	NTU	<2
Settleable Solids	mg/L	0.1
Chlorine Residual	mg/L	0.01
Oil and Grease	mg/L	2.1
Aluminum	μg/L	150
Electrical Conductivity (EC)	μmhos/cm	825
Ammonia (as N)	mg/L	1.5
Arsenic	μg/L	8
Copper	μg/L	7
Cyanide	μg/L	1
Iron	μg/L	50
Manganese	μg/L	10
Methylene Blue Active Substances (MBAS)	μg/L	160
Nitrate (as N)	mg/L	7[2]
Nitrite (as N)	mg/L	1
Bis(2-ethylhexyl)phthalate	μg/L	3.48
Bromodichloromethane	μg/L	ND (< 0.2 μg/L)
Dibromochloromethane	μg/L	ND (< 0.3 μg/L)
Mercury	μg/L	0.01
2,4,6-Trichlorophenol	μg/L	3.28

(1) Unless otherwise noted, all concentrations represent projected mean values taken from City of Manteca WQCF Master Plan Update (Nolte, 2007).

(2) The Nitrate (as N) projected effluent concentration is based on recent WQCF performance data collected by Nolte Associates, Inc., following the installation of nitrification-denitrification facilities in September 2007 (Richard, 2008).

Near-Field Impacts Calculations

The near-field water quality impacts assessment evaluates the effects of increasing WQCF discharge from the permitted 9.87 MGD (ADWF) to a proposed 17.5 MGD (ADWF) effluent flowrate. Near-field effects on San Joaquin River water quality will occur between the point of discharge and WQCF monitoring location R-3 (approximately 1-mile downstream of the WQCF outfall; see **Figure 2**) where advanced treatment effluent and ambient river water are well-mixed as determined by recent hydrodynamic modeling conducted by the City (RMA, 2006). With the exception of the evaluation of whole effluent toxicity included in this report, near-field water

quality impacts are estimated using the following four parameters which characterize WQCF effluent and San Joaquin River water quality:

1. Projected WQCF effluent quality after stabilization of treatment improvements following Phase III expansion (see **Table 10**);

2. Median (50th percentile) ambient San Joaquin River concentrations calculated from data sets comprised of water quality measurements collected during dry and above normal water years;

3. Current permitted and proposed future WQCF effluent flowrates: 9.87 and 17.5 MGD (ADWF); and

4. Average late summer/early fall San Joaquin River flows observed during historic critical (1992) and dry (2002) water years.

The estimated near-field water quality impacts were calculated using the following mass balance equation:

$$C_{downstream} = \frac{\left((C_{upstream})(Q_{upstream})\right) + \left((C_{eff})(Q_{eff} \times 1.55)\right)}{\left(Q_{upstream} + (Q_{eff} \times 1.55)\right)}$$

Where C$_{downstream}$ = San Joaquin River concentration, downstream of discharge at R-3

C$_{upstream}$ = San Joaquin River concentration, upstream of discharge at R-1

C$_{eff}$ = WQCF effluent concentration

Q$_{upstream}$ = San Joaquin River flow (cfs), upstream of discharge at Vernalis

Q$_{eff}$ = WQCF effluent flow (MGD)

Projected average effluent concentrations resulting from proposed improvements to the WQCF treatment process were used to estimate future impacts of the WQCF discharge on San Joaquin River water quality. Median (50th percentile) receiving water concentrations were calculated using data collected at WQCF R-1, where possible. Ambient R-1 concentrations serve as a basis for comparing the magnitude of future change in receiving water quality due to the proposed project. Median constituent concentrations calculated from upstream ambient surface water data were selected for use in the model analysis as a means to estimate a typical long-term average downstream receiving water quality impact due to the proposed increase in the WQCF discharge capacity from the currently permitted 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF). Use of a central tendency statistic, such as the median, characterizes the most commonly observed water quality conditions that occur under a wide range of environmental and hydrologic conditions. It is acknowledged that variability in ambient surface water concentrations and WQCF loadings for individual pollutants occur over time, but use of a median concentration allows for the modeling of a more representative water quality impact than does the use of a concentration characteristic of a less typical best or worst case water quality condition.

All but one of the water quality impacts presented in this analysis was estimated using median upstream surface water concentrations and average WQCF effluent concentrations. Estimated BOD impacts were made using downstream ambient data due to the lack of available upstream San Joaquin River BOD data from dry/below normal water years. In the present analysis, the changes in downstream concentration and mass loading for a pollutant projected to occur as the result of the proposed project are representative of changes to typical or average water quality conditions observed in the project area. Even though the use of a pollutant concentration characteristic of worst case conditions would provide insight into the greatest water quality impact that could occur, this worst case condition would not be representative of typical water quality conditions in terms of both magnitude of the impact and its frequency of occurrence.

Constituents were evaluated under both critical and dry/below normal flow conditions corresponding to critical and dry/below normal water years, respectively. For the critical water year, a San Joaquin River flowrate of 600 cfs was chosen as representative of extremely low flow conditions based on historic monthly average flows calculated for the San Joaquin River at Vernalis during Fall of 1991 and 1992; both years classified as critical by the DWR hydrologic classification scheme (LWA, 2006a). Similarly, a flow of 1,250 cfs was chosen as representative of dry/below normal water year flow conditions based on San Joaquin River at Vernalis flows measured during the Fall of 2002; a year classified as a dry water year (LWA, 2006a). Due to agreements currently in place to provide water for migration of anadromous fish species in the Delta (1995 Bay-Delta Plan; SWRCB, 2006; and the Revised Water Right Decision 1641; SWRCB, 2000), as well as future San Joaquin River flow objectives that may be set forth in a future Bay-Delta Plan, future San Joaquin River flows should be similar to or greater than those observed during historic dry water years during future rainfall-limited years. Evaluating changes in San Joaquin River water quality due to an increase in WQCF effluent discharged under critical water year flow conditions therefore represents a conservative approach to the assessment of potential impacts of the proposed project on the receiving water quality.

Near-Field Analysis and Results

The analysis and results for each constituent specified in **Table 7** selected for near-field analysis are summarized on individual fact sheets in the remainder of this section. Each fact sheet contains information for the following items: data availability, the results of increasing WQCF discharge from the current permitted 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF), a graphical representation of the estimated change in San Joaquin River concentrations at WQCF R-3 due to a increase in WQCF discharge, a comparison to applicable water quality objectives or criteria, a summary evaluation of the findings of the analysis, and tabularized calculated results of estimated water quality conditions.

Biochemical Oxygen Demand (BOD)

Data Availability: DWR-MWQI monitoring data from the San Joaquin River at Mossdale (just downstream of the WQCF discharge) corresponding to a dry water year were used to calculate an estimated impact of WQCF effluent biochemical oxygen demand (BOD) in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at the proposed discharge of 17.5 MGD (ADWF). Improved WQCF treatment processes are projected to produce treated effluent having an average BOD concentration of 7 mg/L.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will produce a slight increase in BOD in the San Joaquin River downstream of the discharge as shown in **Figure 5** and **Table 11**. A slight increase in BOD mass loading to the river is also projected.
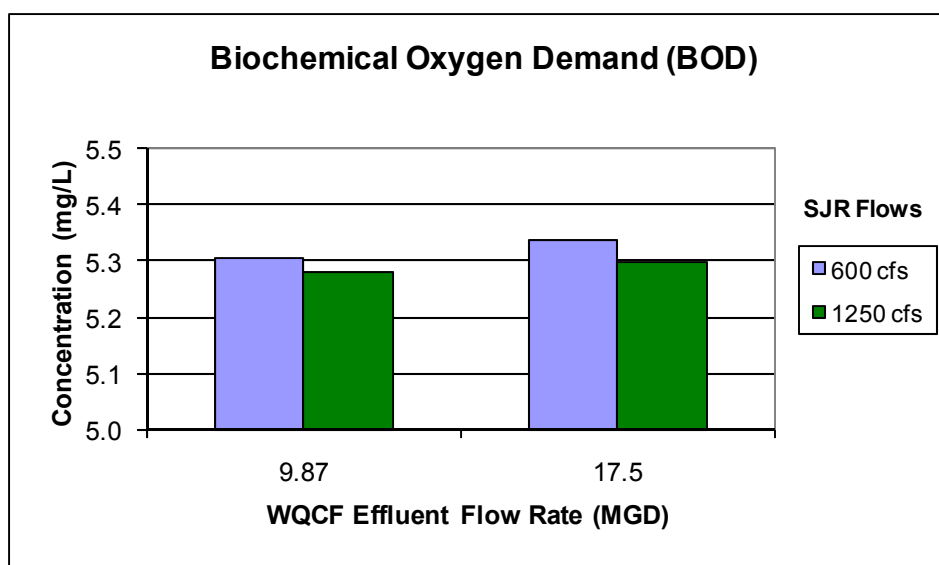
Figure 5: Projected Change in San Joaquin River Biochemical Oxygen Demand Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: Currently, there is no adopted water quality objective for BOD in the San Joaquin River. However, the consumptive oxygen demand of BOD will reduce ambient DO levels in the river, and therefore a nexus exists between BOD and DO concentrations. The influence of the WQCF BOD input is most strongly expressed as an oxygen demand downstream of the City's wastewater outfall, and therefore the impact of WQCF effluent BOD levels in the San Joaquin River is addressed in the Far-Field Analysis and Results section of this report in a discussion of far-field DO impacts. This near-field BOD impact analysis serves as the starting point for the far-field DO impact analysis. Estimated concentrations of BOD in the San Joaquin River under critical and dry/below normal flow conditions show a minor increase with an increase in WQCF effluent discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The incremental change in BOD concentration in the river is

minor when increasing the WQCF discharge from the current permitted discharge of 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF).

Evaluation: There is a slight increase in BOD mass loading in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)). The increase in discharge also results in a slight increase in the BOD concentration in the San Joaquin River downstream of the WQCF. Additionally, treatment process upgrades including a high-rate activated sludge process and tertiary filtration in accordance with Title 22 standards and UV disinfection conforming to National Water Research Institute (NWRI) guidelines will produce effluent concentrations of BOD less than 10 mg/L. The associated consumptive oxygen demand downstream of the WQCF discharge due to BOD inputs is addressed in the Far-Field Analysis and Results section of this report in a discussion of far-field DO impacts.

Table 11: Estimated Impact of Biochemical Oxygen Demand from WQCF Discharge in the San Joaquin River at WQCF R-3

Biochemical Oxygen Demand (BOD)		San Joaquin River Flowrate (cfs)		Manteca WQCF Effluent Flowrate (MGD ADWF)	
Mossdale 50th % concen. (mg/L)*	**5.26**				
Projected effluent concen. (mg/L)	**7**	*600*	*1250*	*9.87*	*17.5*
Estimated mass loading (lbs/day)		17,011	35,439	576	1,022
Estimated downstream R-3 river concen. (mg/L) at 600 cfs				5.30	5.34
Estimated downstream R-3 river concen. (mg/L) at 1250 cfs				5.28	5.30

* 50th percentile statistic calculated using the following data set:
Data Period: October 2000 – October 2001; Sample Size, n = 10; Percent Detected Data = 100%

Total Suspended Solids (TSS)

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to a wet water year were used to calculate an estimated impact of WQCF effluent total suspended solids (TSS) in the San Joaquin River. Ideally, an R-1 TSS data set corresponding to dry/below normal water years would be used for the present analysis, but such a data set was not available. Improved WQCF treatment processes are projected to produce treated effluent having an average TSS concentration of less than 10 mg/L. For the purpose of the current analysis, and to be conservative, future TSS effluent concentration was considered to be 10 mg/L.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will slightly decrease TSS concentrations in the San Joaquin River downstream of the discharge as shown in **Figure 6** and **Table 12**. A slight increase in TSS mass loading to the river is also projected. The use of wet water year TSS data may have imparted a slightly high bias to the calculation of downstream, estimated TSS concentrations in the San Joaquin River. Actual future TSS concentrations measured during dry/below normal water years in the San Joaquin River might be slightly lower than presently estimated.

Figure 6: Projected Change in San Joaquin River Total Suspended Solids Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The Basin Plan's narrative objective for *suspended material* states:

> "Waters shall not contain suspended material in concentrations that cause or adversely affect beneficial uses."

The results of the present analysis indicate that TSS concentration in the San Joaquin River will slightly decrease with increasing WQCF effluent discharge, thus lessening the concentration of suspended material in the river and complying with the narrative water quality objective. Furthermore, NPDES permit effluent limitations will be sufficiently stringent to provide the intended level of protection to the beneficial uses of the San Joaquin River.

Evaluation: Because WQCF effluent TSS concentration is lower than the ambient TSS concentration in the San Joaquin River, increasing WQCF effluent discharge will decrease receiving water concentrations. TSS mass loading to the river is projected to be slight relative to existing in-stream loads. Additionally, with a high-rate activated sludge process, an easily filterable secondary effluent will be produced. Following tertiary filtration in accordance with Title 22 standards and UV disinfection conforming to National Water Research Institute (NWRI) guidelines, effluent concentrations of suspended solids will be less than 10 mg/L.

Table 12: Estimated Impact of Total Suspended Solids from WQCF Discharge in the San Joaquin River at WQCF R-3

Total Suspended Solids (TSS)		San Joaquin River Flowrate (cfs)		Manteca WQCF Effluent Flowrate (MGD ADWF)	
R-1 50th % concen. (mg/L)*	**25.7**				
Projected effluent concen. (mg/L)	**10**	*600*	*1250*	*9.87*	*17.5*
Estimated mass loading (lbs/day)		83,114	173,154	823	1,460
Estimated downstream R-3 river concen. (mg/L) at 600 cfs				25.3	25.0
Estimated downstream R-3 river concen. (mg/L) at 1250 cfs				25.5	25.4

* 50th percentile statistic calculated using the following data set:
Data Period: November 2005 – July 2006; Sample Size, n = 16; Percent Detected Data = 100%

Aluminum

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to dry/below normal water years were used to calculate an estimated impact of WQCF effluent total aluminum in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and a proposed discharge of 17.5 MGD (ADWF). Improved WQCF treatment processes are projected to produce treated effluent having an average total aluminum concentration of 150 µg/L.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will slightly decrease total aluminum concentration in the San Joaquin River downstream of the discharge as shown in **Figure 7** and **Table 13**. A slight increase in total aluminum mass loading to the river is also projected.

The column chart also indicates that estimated concentrations of total aluminum in the river far exceed the U.S. EPA chronic ambient water quality criterion (87 µg/L) for the metal (USEPA, 2002), which is often used by the Regional Water Board to interpret the narrative toxicity objective contained in the Basin Plan. Current permitted WQCF effluent limitations for total aluminum include a monthly average of 71 µg/L and a daily maximum of 140 µg/L. Past water quality data collected by the WQCF indicate that aluminum concentrations in the effluent – and the San Joaquin River – exceed these limitations. Therefore, the City is exploring various compliance options to meet these effluent limits.

The City has been granted the opportunity by the Regional Water Board to assess compliance with the aluminum effluent limits using the acid soluble method for aluminum analysis and/or by conducting a Water Effects Ratio (WER) to develop a site specific objective (SSO). Based on analytical results, the acid-soluble measurement does not appear to be useful or applicable to compliance measurement because the analysis of the acid-soluble portion of a total metal commonly does not result in significantly lower values of the total metal when compared to the analysis of the metal without acidification. In contrast, the City's aluminum WER study (City of Manteca, 2007) recommended a WER of 22.7 for direct adjustment of the chronic objective. This WER would also be applicable to the corresponding acute objective. The 87 µg/L U.S. EPA chronic criterion is based on toxicity tests using striped bass and brook trout in water with pH between 6.5 and 6.6 and hardness concentrations (as $CaCO_3$) of less than 10 mg/L (striped bass) and 12.3 mg/L (brook trout). WER studies conducted since this time and anecdotal evidence support the conclusion that aluminum is substantially less toxic at the higher pH and hardness values that are typical in the San Joaquin River. This conclusion is supported by the City's WER study, which noted only one case when there was a negative response to an aluminum-dosed environmental sample (effluent, upstream, or simulated downstream). Additionally, studies completed by other San Joaquin River dischargers have indicated that WERs exceeding 20 are scientifically defendable.
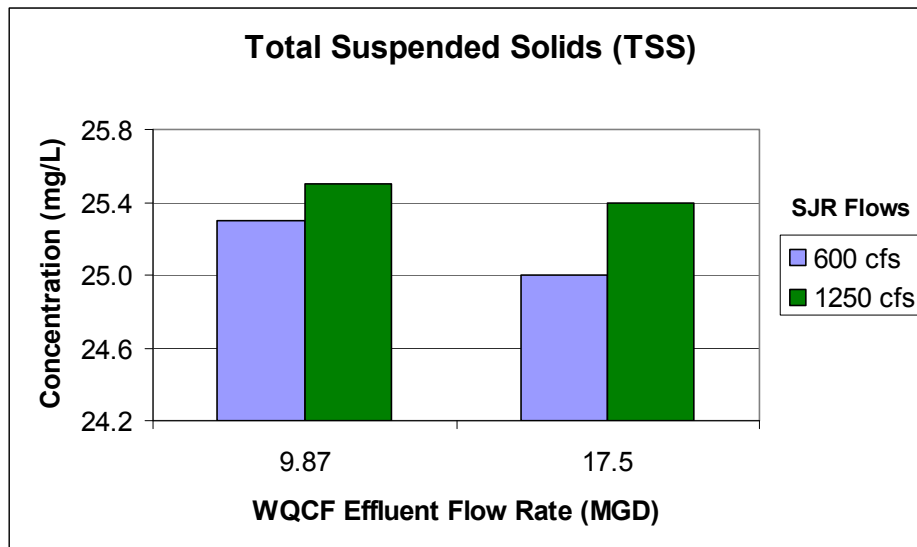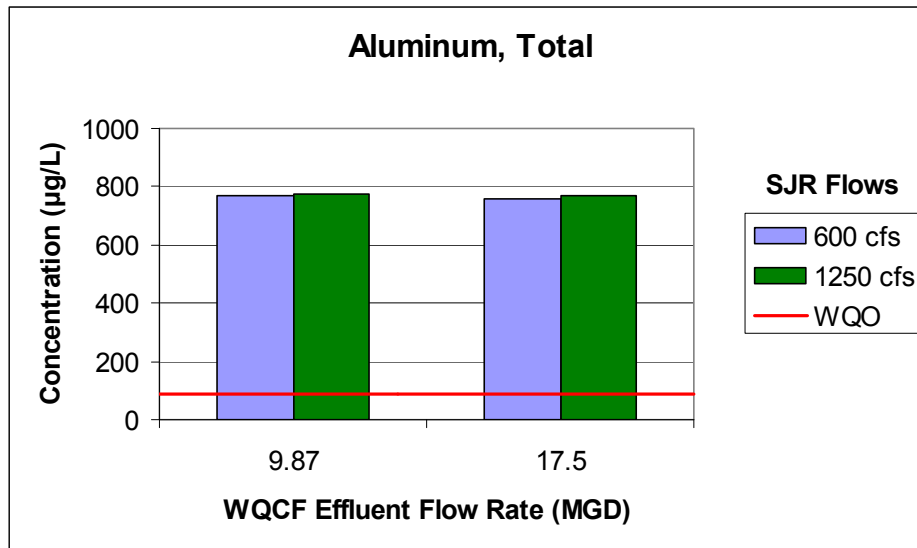
Figure 7: Projected Change in San Joaquin River Total Aluminum Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The U.S. EPA chronic ambient water quality criterion for total aluminum, which is often used by the Regional Water Board to interpret the narrative toxicity objective contained in the Basin Plan, is 87 µg/L. The WER study (City of Manteca, 2007) recently completed by the City for the purpose of identifying an appropriate SSO for total aluminum in the San Joaquin River indicates that a WER of 22.7 in scientifically defendable. To this end, the next lowest water quality standard for aluminum (Title 22 Secondary Maximum Contaminant Level (MCL) of 200 µg/L) may be applicable to WQCF effluent. Title 22 Secondary MCLs are set to evaluate potable water that has received treatment, including filtration that generally removes the particulate materials from the water, leaving essentially only the dissolved fraction. However, Title 22 standards do not directly specify whether the total or dissolved phase should be considered. Applying Secondary MCLs directly to surface water warrants consideration in that only the dissolved fraction would ultimately pass through a drinking water treatment plant. The Regional Water Board has requested an opinion from the California Department of Public Health (CDPH) as to whether Secondary MCLs should be applied to the total or dissolved fraction in receiving waters. CDPH responded[2] stating that application of Secondary MCLs as dissolved is sufficient to protect municipal and drinking water users. The Regional Water Board has indicated that only the numbers from the Tables of Title 22 Secondary MCLs are incorporated into the Basin Plan by reference, and will continue to apply the value of the Secondary MCL standard to the total concentration of the constituent in the receiving water to provide protection for persons directly using the river as their water source.

Evaluation: The current U.S. EPA chronic water quality criterion for total aluminum as applied to the San Joaquin River is believed to be over restrictive and over protective of beneficial uses

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[2] Letter from Carl Lischeske, CDPH Region Chief, to Kenneth Landau, Region 5 Assistant Executive Officer, regarding Yuba City Wastewater Treatment Plant, dated April 10, 2007.

because the criterion does not take into account the local water quality characteristics (high pH and high hardness) that mitigate toxicity of aluminum to aquatic life. The criterion was developed based on a study conducted for striped bass and brook trout that was low in pH and hardness. The City has recently completed a WER study as a means of identifying an appropriate water quality objective for aluminum in the San Joaquin River that is both sufficiently protective of aquatic life and identifies available assimilative capacity for aluminum in the river under which the WQCF can discharge its effluent. Regardless, an increase in permitted discharge capacity from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) does not negatively impact the San Joaquin River, and in fact will decrease total aluminum concentrations in the receiving water.

Table 13: Estimated Impact of Total Aluminum from WQCF Discharge in the San Joaquin River at WQCF R-3

Aluminum, Total		*San Joaquin River Flowrate (cfs)*		*Manteca WQCF Effluent Flowrate (MGD ADWF)*	
R-1 50th % concen. (µg/L)*	**785.1**				
Projected effluent concen. (µg/L)	**150**	*600*	*1250*	*9.87*	*17.5*
Estimated mass loading (lbs/day)		2,539	5,290	12.3	21.9
Estimated downstream R-3 river concen. (µg/L) at 600 cfs				769.3	757.6
Estimated downstream R-3 river concen. (µg/L) at 1250 cfs				777.4	771.6

* 50th percentile statistic calculated using the following data set:
Data Period: January 2002 – September 2004; Sample Size, n = 14; Percent Detected Data = 100%

Electrical Conductivity

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to dry/below normal water years were used to calculate an estimated impact of WQCF effluent EC in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). Ongoing changes in the City of Manteca potable water supply and improved WQCF treatment processes are projected to result in treated effluent with an average EC of 825 µmho/cm.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. Due to the seasonal EC objectives contained in the Basin Plan, available ambient EC data were divided into two groups for the purpose of the present near-field analysis: an April through August data set, and a September through March data set. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will produce a slight increase in EC in the San Joaquin River downstream of the discharge during both the April through August and the September through March periods, relative to their respective seasonal objectives of 700 µmhos/cm and 1000 µmhos/cm. These incremental increases in river EC observed when evaluating the April through August (agricultural season) and September through March (non-agricultural season) time periods are shown in **Figure 8** and **Table 14**, and **Figure 9** and **Table 15**, respectively.
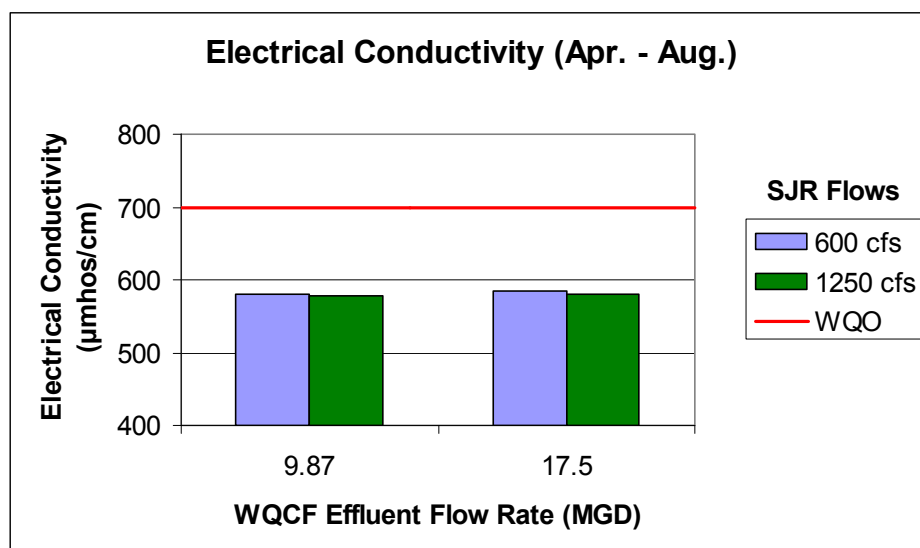
Figure 8: Projected Change in San Joaquin River Electrical Conductivity at WQCF R-3 during April through August with increasing WQCF Effluent Flowrate
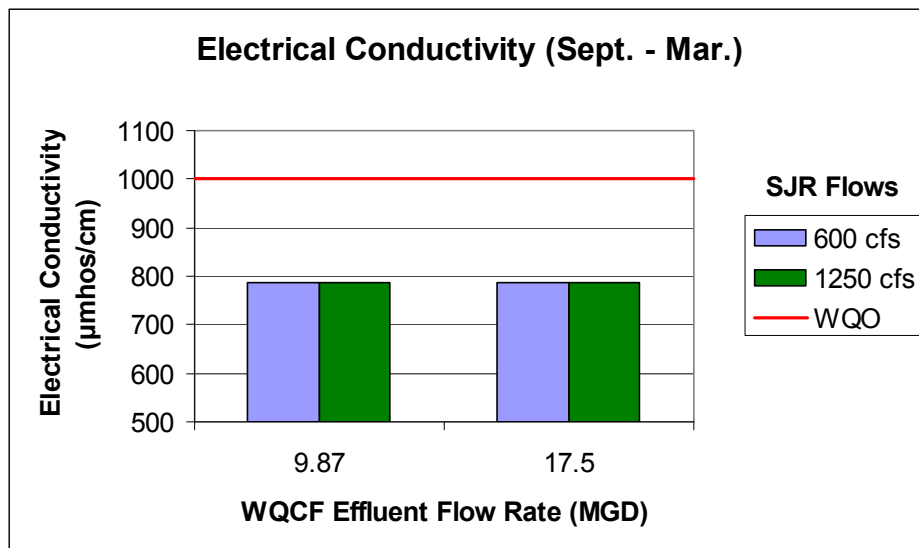
Figure 9: Projected Change in San Joaquin River Electrical Conductivity at WQCF R-3 during September through March with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The Basin Plan for the Delta establishes seasonal EC objectives in the San Joaquin River and southern Delta of 700 µmhos/cm (April – August) and 1000 µmhos/cm (September – March). Estimated EC in the San Joaquin River under critical and dry/below normal flow conditions shows a slight increase during both these periods relative to their respective 700 µmhos/cm and 1000 µmhos/cm objectives, with an increase in WQCF effluent discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). Under both seasonal EC objective scenarios (see **Figure 8** and **Figure 9**) the projected median EC in the San Joaquin River is well below the seasonally-relevant Basin Plan EC objective.

Evaluation: Salinity control issues in the Delta have been reviewed and addressed by the State Water Board as far back as 1991, as described in the 1991 Delta Plan (SWRCB, 1991). Subsequent State Water Board analyses of elevated salinity in the southern Delta presented in the Revised Water Right Decision 1641 (SWRCB, 2000) and 2006 Bay-Delta Plan (SWRCB, 2006) conclude that salinity problems in the southern Delta are the result of many inter-related conditions, including water diversions upstream of the Delta, water diversions within the Delta for export and local use, high levels of salinity in irrigation return flows discharged to the Delta waterways and tributaries, municipal discharges, groundwater inflow, seasonal flow variation, and tidal conditions. Although the discharge of treated wastewater to the Delta or its tributaries under an NPDES permit can marginally affect EC in the southern Delta, its relative impact on salinity in the region compared to the other sources listed above is minor.

In regard to the present analysis, the incremental change in EC in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)) is slight during both the agricultural and non-agricultural seasons, relative to their respective 700 µmhos/cm and 1000 µmhos/cm objectives. Most importantly, the levels of EC in the WQCF effluent have steadily been decreasing in recent years. Prior to mid 2005, the City was exclusively using groundwater for its potable water source. The groundwater in the area is high in total dissolved solids (TDS) and it was frequently

causing EC levels in the effluent to exceed the plant's current 1000 μmhos/cm NPDES limit. Beginning in July and August 2005, the City started replacing a portion of its potable water supply with surface water from the new South San Joaquin Irrigation District water plant. As the amount of blended surface water has gradually increased, the EC levels measured in the WQCF effluent have steadily decreased.

Table 14: Estimated Impact of Electrical Conductivity during April through August from WQCF Discharge in the San Joaquin River at WQCF R-3

Electrical Conductivity (April – August)		*Manteca WQCF Effluent Flowrate (MGD ADWF)*	
R-1 50th % EC (μmhos/cm)*	574.9		
Projected effluent EC (μmhos/cm)	825	*9.87*	*17.5*
Estimated downstream R-3 river EC (μmhos/cm) at 600 cfs		581.1	585.7
Estimated downstream R-3 river EC (μmhos/cm) at 1250 cfs		577.9	580.2

* 50th percentile statistic calculated using the following data set:
Data Period: Apr. – Aug. 2002, Apr. – May. 2004; Sample Size, n = 8; Percent Detected Data = 100%

Table 15: Estimated Impact of Electrical Conductivity during September through March from WQCF Discharge in the San Joaquin River at WQCF R-3

Electrical Conductivity (September - March)		*Manteca WQCF Effluent Flowrate (MGD ADWF)*	
R-1 50th % EC (μmhos/cm)*	785.9		
Projected effluent EC (μmhos/cm)	825	*9.87*	*17.5*
Estimated downstream R-3 river EC (μmhos/cm) at 600 cfs		786.9	787.6
Estimated downstream R-3 river EC (μmhos/cm) at 1250 cfs		786.4	786.7

* 50th percentile statistic calculated using the following data set:
Data Period: Jan. – Mar. 2002, Sept. – Dec. 2002, Sept. 2004; Sample Size, n = 8; Percent Detected Data = 100%

Ammonia

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to dry/below normal water years were used to calculate an estimated impact of WQCF effluent ammonia (as nitrogen) in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). Improved WQCF treatment processes are projected to produce treated effluent having an average ammonia (as nitrogen) concentration of 1.5 mg/L.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. Due to the seasonal nexus of U.S. EPA ambient water quality criteria for ammonia (as nitrogen), available ammonia data were divided into two groups for the purpose of the present near-field analysis: a June through September data set, and an October through May data set. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will produce a minor increase in ammonia (as nitrogen) levels in the San Joaquin River downstream of the discharge during June through September relative to its seasonal objective of 0.62 mg/L, and will produce a slight increase in ammonia (as nitrogen) levels in the river during October through May relative to its seasonal objective of 5.62 mg/L. These incremental increases in river ammonia (as nitrogen) concentrations and mass loadings observed when evaluating the June through September (associated with the EPA chronic ammonia criterion) and October through May (associated with the EPA acute ammonia criterion) time periods are shown in **Figure 10** and **Table 16**, and **Figure 11** and **Table 17**, respectively.
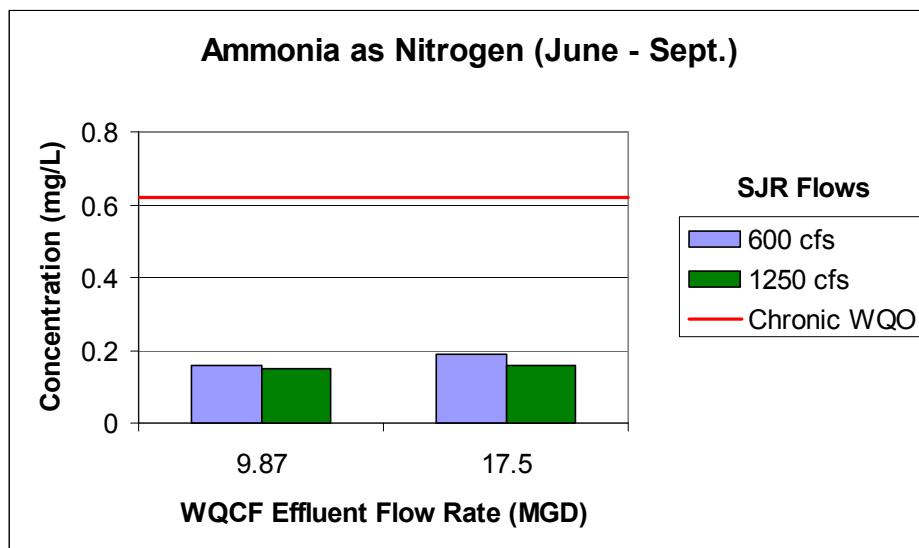
Figure 10: Projected Change in San Joaquin River Ammonia (as Nitrogen) Concentration at WQCF R-3 during June through September with increasing WCQF Effluent Flowrate
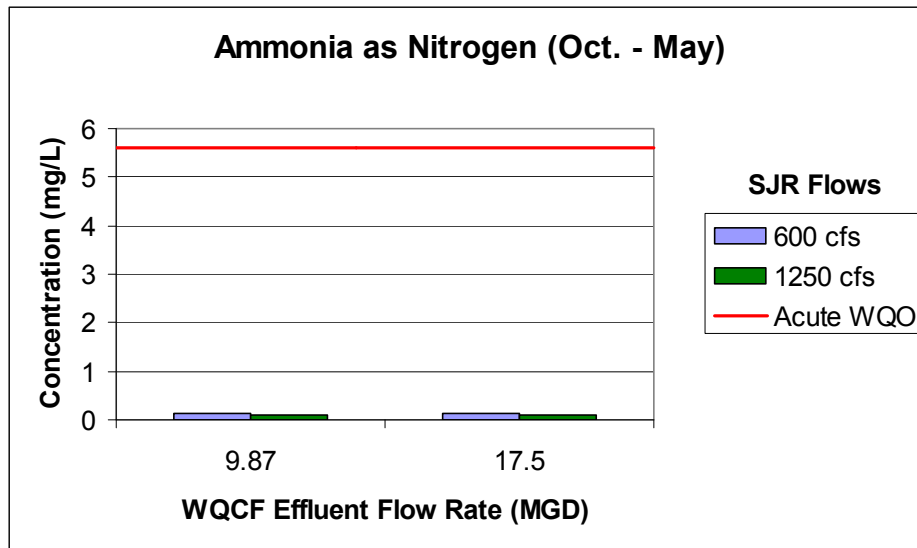
Figure 11: Projected Change in San Joaquin River Ammonia (as Nitrogen) Concentration at WQCF R-3 during October through May with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The U.S. EPA ambient water quality criteria that are applied to ammonia concentrations in the San Joaquin River are pH and temperature dependent. The acute and chronic criteria for ammonia as promulgated by U.S. EPA 1999 Update of Ambient Water Quality Criteria for Ammonia are used by the Regional Water Board to interpret the Basin Plan's narrative toxicity objective. Using a pH of 8.4 standard units and a temperature 26°C, previously used by the Regional Board in WDR Order No. R5-2004-0028, a chronic criterion of 0.62 mg/L ammonia (as nitrogen) can be calculated and applied to the San Joaquin River during June through September. Similarly, an acute criterion of 5.62 mg/L ammonia (as nitrogen) can be calculated and applied to the San Joaquin River during October through May based on an ambient pH of 8.0 standard units. The acute ammonia criterion is not temperature dependent. Estimated concentrations of ammonia (as nitrogen) in the San Joaquin River under critical and dry/below normal flow conditions show a minor increase relative to the chronic EPA criterion during June through September, and only a slight increase relative to the acute EPA criterion during October through May, with an increase in WQCF effluent discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). In an analysis of compliance with chronic and acute seasonal objectives (**Figure 10** and **Figure 11**), projected median ammonia (as nitrogen) concentrations in the San Joaquin River remain below the more stringent chronic ammonia objective (0.62 mg/L) calculated for the river on a year round basis.

Evaluation: The present analysis shows that projected, median ammonia (as nitrogen) concentrations in the San Joaquin River are below the more stringent chronic criterion of 0.62 mg/L during the June through September time period, and substantially lower than the acute criterion of 5.62 mg/L during the October through May time period. The consumptive oxygen demands of ammonia nitrification are most strongly expressed downstream of the City's wastewater outfall, and therefore the impact of WQCF effluent ammonia levels on DO levels in the San Joaquin River is addressed in the Far-Field Analysis and Results section of this report in a discussion of far-field DO impacts. Additionally, it should be noted that ammonia levels will

decline over time and distance downstream of R-3 as ammonia is utilized by phytoplankton and other primary producers.

Table 16: Estimated Impact of Ammonia (as Nitrogen) from WQCF Discharge during June through September in the San Joaquin River at WQCF R-3

Ammonia as Nitrogen (June – Sept.)		San Joaquin River Flowrate (cfs)		Manteca WQCF Effluent Flowrate (MGD ADWF)	
R-1 50th % concen. (mg/L)*	0.13				
Projected effluent concen. (mg/L)	1.5	600	1250	9.87	17.5
Estimated mass loading (lbs/day)		420	876	123	219
Estimated downstream R-3 river concen. (mg/L) at 600 cfs				0.16	0.19
Estimated downstream R-3 river concen. (mg/L) at 1250 cfs				0.15	0.16

* 50th percentile statistic calculated using the following data set:
Data Period: June 2002 – September 2002, September 2004; Sample Size, n = 5; Percent Detected Data = 80%

Table 17: Estimated Impact of Ammonia (as Nitrogen) from WQCF Discharge during October through May in the San Joaquin River at WQCF R-3

Ammonia as Nitrogen (Oct. – May)		San Joaquin River Flowrate (cfs)		Manteca WQCF Effluent Flowrate (MGD ADWF)	
R-1 50th % concen. (mg/L)*	0.08				
Projected effluent concen. (mg/L)	1.5	600	1250	9.87	17.5
Estimated mass loading (lbs/day)		259	539	123	219
Estimated downstream R-3 river concen. (mg/L) at 600 cfs				0.12	0.14
Estimated downstream R-3 river concen. (mg/L) at 1250 cfs				0.10	0.11

* 50th percentile statistic calculated using the following data set:
Data Period: January 2002 – May 2002, October 2002 – May 2004; Sample Size, n = 11; Percent Detected Data = 72.7%

Arsenic

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to dry/below normal water years were used to calculate an estimated impact of WQCF effluent dissolved arsenic in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). Ongoing improvements in the water quality of the City of Manteca potable water supply and improvements in the WQCF treatment processes are projected to result in treated effluent having an average total arsenic concentration of 8 μg/L. For the purpose of the current analysis, and to be conservative, all arsenic present in WQCF treated effluent is assumed to be in the dissolved form.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will slightly increase dissolved arsenic concentration in the San Joaquin River, relative to its Basin Plan objective, downstream of the discharge as shown in **Figure 12** and **Table 18**. A slight increase in dissolved arsenic mass loading to the river is also projected.

Figure 12: Projected Change in San Joaquin River Dissolved Arsenic Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The Basin Plan objective for dissolved arsenic in the Delta is 10 μg/L, expressed as the dissolved fraction (Basin Plan, Table III-1). Estimated concentrations of dissolved arsenic in the San Joaquin River under critical and dry/below normal flow conditions show a slight increase, relative to the Basin Plan objective, with an increase in WQCF effluent discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The incremental change in dissolved arsenic concentration in the river is slight when increasing the WQCF discharge from the current permitted discharge of 9.87 MGD (ADWF) to the proposed 17.5

MGD (ADWF). Projected, median dissolved arsenic concentrations in the San Joaquin River are significantly below the Basin Plan objective.

Evaluation: The incremental change in dissolved arsenic concentration in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)) is slight and below the magnitude of change that could be reliably measured in the field. Similarly, the projected increase in dissolved arsenic mass loading to the river is also slight. The levels of dissolved arsenic in the WQCF effluent have steadily been decreasing in recent years, as the City has started replacing a portion of its potable water supply with surface water. In addition, further reductions are expected with completion of a current project for installing groundwater treatment at City wells. Projected, median dissolved arsenic concentrations in the San Joaquin River are well below the Basin Plan objective of 10 μg/L.

Table 18: Estimated Impact of Dissolved Arsenic from WQCF Discharge in the San Joaquin River at WQCF R-3

Arsenic, Dissolved		*San Joaquin River Flowrate (cfs)*		*Manteca WQCF Effluent Flowrate (MGD ADWF)*	
R-1 50th % concen. (μg/L)*	**1.92**				
Projected effluent concen. (μg/L)	**8**[1]	*600*	*1250*	*9.87*	*17.5*
Estimated mass loading (lbs/day)		8	18	0.7	1.2
Estimated downstream R-3 river concen. (μg/L) at 600 cfs				2.07	2.18
Estimated downstream R-3 river concen. (μg/L) at 1250 cfs				1.99	2.05

* 50th percentile statistic calculated using the following data set:
Data Period: February 2002 – December 2002; Sample Size, n = 11; Percent Detected Data = 91%

(1) The projected effluent concentration is provided as total arsenic; conservatively, it is assumed that all arsenic present in WQCF treated effluent exists in the dissolved form.

Copper

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to dry/below normal water years were used to calculate an estimated impact of WQCF effluent dissolved copper in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). A significant level of copper removal is expected through the advanced wastewater treatment (filtration) recently implemented in September 2007 as part of the WQCF Phase III upgrades. Historical improvements in removal efficiencies at similar advanced treatment plants are on the order of 25 percent (Nolte, 2007). Initial results from effluent monitoring events conducted following filtration implementation appear to confirm these expectations. Additionally, for the purpose of the current analysis, and to be conservative, all copper present in WQCF treated effluent is assumed to be in the dissolved form.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will slightly increase dissolved copper concentration in the San Joaquin River, relative to its Basin Plan objective, downstream of the discharge as shown in **Figure 13** and **Table 19**. A slight increase in dissolved copper mass loading to the river is also projected.

Figure 13: Projected Change in San Joaquin River Dissolved Copper Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The CTR freshwater chronic objective calculated for dissolved copper in the San Joaquin River is 14.24 µg/L when using a river hardness value of 172 mg/L measured during the low fall flows of October 2002 at WQCF R-1. To that end, the more stringent Basin Plan dissolved copper objective of 10 µg/L (Basin Plan, Table III-1) is used for assessing the impact of increased WQCF discharge on dissolved copper levels in the San

Joaquin River. Estimated concentrations of dissolved copper in the San Joaquin River under critical and dry/below normal flow conditions show a slight increase with an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The incremental change in dissolved copper concentration in the river is slight when increasing the WQCF discharge from the current permitted discharge of 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF). Projected, median dissolved copper concentrations in the San Joaquin River are below the Basin Plan objective.

Evaluation: The incremental change in dissolved copper concentration in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)) is slight and below the magnitude of change that could be reliably measured in the field. Similarly, the projected increase in dissolved copper mass loading to the river is also slight. A significant level of copper removal will be accomplished through advanced wastewater treatment (filtration) implemented as one of several treatment process improvements associated with the WQCF Phase III upgrade. Historical removal efficiencies at similar advanced treatment plants are on the order of 25 percent (Nolte, 2007). Initial results from effluent monitoring events conducted following filtration implementation appear to confirm these expectations. The analysis calculates projected median dissolved copper concentrations in the San Joaquin River that are substantially below the Basin Plan objective of 10 μg/L.

Table 19: Estimated Impact of Dissolved Copper from WQCF Discharge in the San Joaquin River at WQCF R-3

Copper, Dissolved		San Joaquin River Flowrate (cfs)		Manteca WQCF Effluent Flowrate (MGD ADWF)	
R-1 50th % concen. (μg/L)*	**1.91**				
Projected effluent concen. (μg/L)	**7(1)**	*600*	*1250*	*9.87*	*17.5*
Estimated mass loading (lbs/day)		11	22	0.6	1.0
Estimated downstream R-3 river concen. (μg/L) at 600 cfs				2.04	2.13
Estimated downstream R-3 river concen. (μg/L) at 1250 cfs				1.97	2.02

* 50th percentile statistic calculated using the following data set:
Data Period: February 2002 – December 2002; Sample Size, n = 11; Percent Detected Data = 91%
(1) The projected effluent concentration is provided as total copper; conservatively, it is assumed that all copper present in WQCF treated effluent exists in the dissolved form.

Cyanide

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to dry/below normal water years were used to calculate an estimated impact of WQCF effluent total cyanide in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). The treatment plant's UV disinfection process, recently introduced in September 2007, is expected to produce treated effluent having an average total cyanide concentration of 1 µg/L (half of the current minimum analytical detection level). Initial available results from a limited number of monitoring events conducted in the period following UV installation indicate that effluent cyanide levels have been below analytical detection levels.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will slightly increase total cyanide concentration in the San Joaquin River, relative to its CTR objective, downstream of the discharge as shown in **Figure 14** and **Table 20**. A slight increase in total cyanide mass loading to the river is also projected.
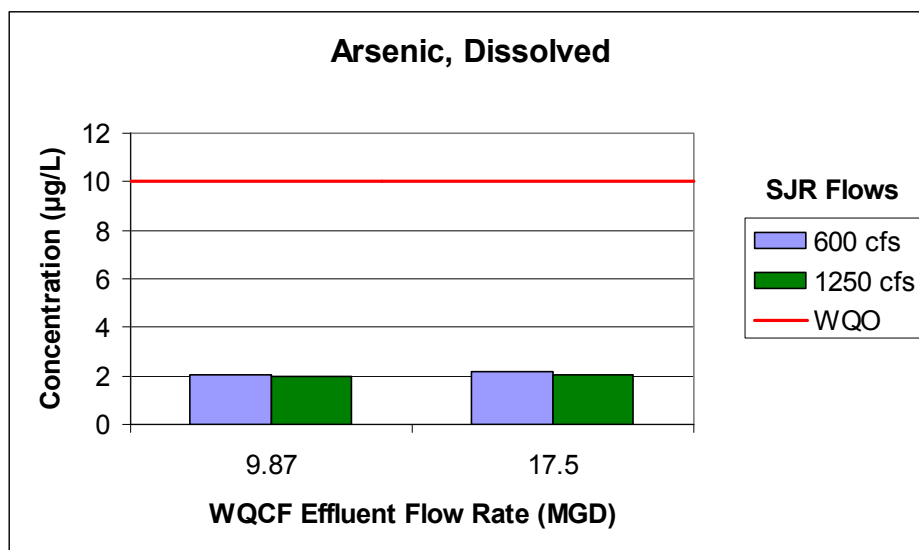

Figure 14: Projected Change in San Joaquin River Total Cyanide Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The CTR freshwater chronic objective for total cyanide as it applies to the San Joaquin River is 5.2 µg/L. The CTR total cyanide objective is not hardness dependent as are some other CTR metals objectives. Estimated concentrations of total cyanide in the San Joaquin River under critical and dry/below normal flow conditions show a slight increase, relative to the CTR objective, with an increase in WQCF effluent discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The incremental change in total cyanide concentration in the river is slight when increasing the WQCF discharge from the current permitted discharge of 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF). Projected,

median total cyanide concentrations in the San Joaquin River are well below the CTR freshwater chronic objective.

Evaluation: The incremental change in total cyanide concentration in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)) is slight and below the magnitude of change that could be reliably measured in the field. Similarly, the projected increase in total cyanide mass loading to the river is also slight. Additionally, projected, median total cyanide concentrations in the San Joaquin River are well below the CTR freshwater chronic objective of 5.2 μg/L.

Table 20: Estimated Impact of Total Cyanide from WQCF Discharge in the San Joaquin River at WQCF R-3

Cyanide, Total		San Joaquin River Flowrate (cfs)		Manteca WQCF Effluent Flowrate (MGD ADWF)	
R-1 50th % concen. (μg/L)*	0.28				
Projected effluent concen. (μg/L)	1	600	1250	9.87	17.5
Estimated mass loading (lbs/day)		1	2	0.08	0.15
Estimated downstream R-3 river concen. (μg/L) at 600 cfs				0.30	0.31
Estimated downstream R-3 river concen. (μg/L) at 1250 cfs				0.29	0.30

* 50th percentile statistic calculated using the following data set:
Data Period: January 2002 – December 2002; Sample Size, n = 12; Percent Detected Data = 25%

Iron

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to a wet water year were used to calculate an estimated impact of WQCF effluent dissolved iron in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). Ideally, an R-1 dissolved iron data set corresponding to dry/below normal water years would be used for the present analysis, but such a data set was not available. Improved WQCF treatment processes are projected to produce treated effluent having an average total iron concentration of 50 µg/L. For the purpose of the current analysis, and to be conservative, all iron present in WQCF treated effluent is assumed to be in the dissolved form.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will in fact slightly decrease dissolved iron concentration in the San Joaquin River, relative to the Basin Plan objective, downstream of the discharge as shown in **Figure 15** and **Table 21**. A slight increase in dissolved iron mass loading to the river is also projected.
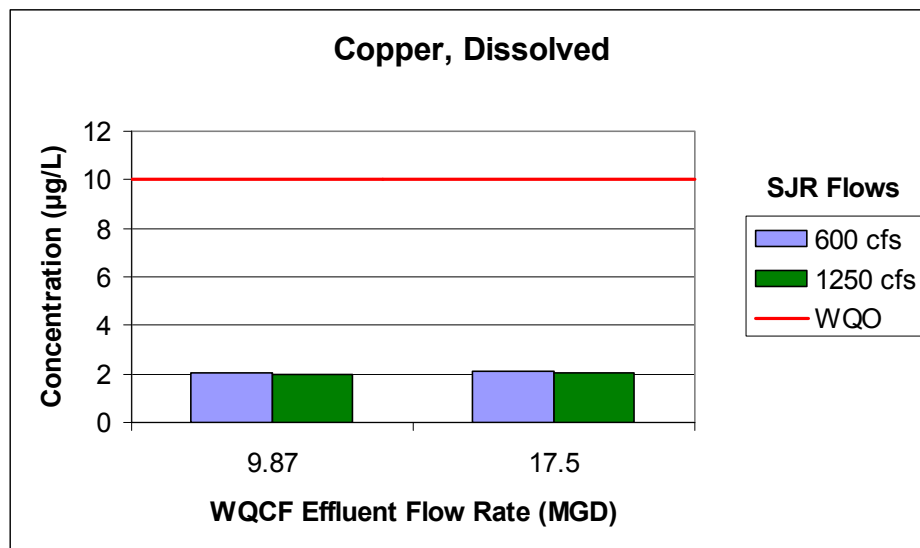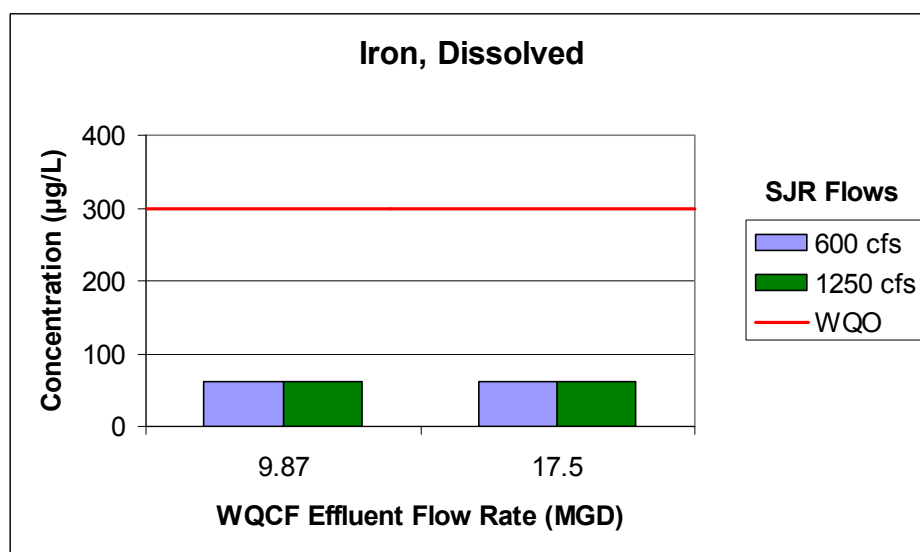

Figure 15: Projected Change in San Joaquin River Dissolved Iron Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The Basin Plan objective for dissolved iron for the Delta is 300 µg/L, expressed as the dissolved fraction (Basin Plan, Table III-1). This Title 22 Secondary MCL is the appropriate and most stringent water quality objective to apply to iron in the San Joaquin River. Estimated concentrations of dissolved iron in the San Joaquin River under critical and dry/below normal flow conditions show a slight decrease, relative to the Basin Plan objective, with an increase in WQCF effluent discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The incremental change in the dissolved iron mass loading in the river is slight

upon completion of the proposed WQCF Phase IV expansion. Projected, median dissolved iron concentrations in the San Joaquin River are well below the Basin Plan objective.

Evaluation: The incremental change in dissolved iron concentration in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)) manifests itself as a slight decrease under critical and dry/below normal flow conditions due to the lower effluent concentration of the dissolved metal relative to the river. Dissolved iron mass loading to the river is projected to be slight relative to existing in-stream loads. Additionally, projected dissolved iron concentrations in the San Joaquin River are well below the Basin Plan objective of 300 μg/L.

Table 21: Estimated Impact of Dissolved Iron from WQCF Discharge in the San Joaquin River at WQCF R-3

Iron, Dissolved		San Joaquin River Flowrate (cfs)		Manteca WQCF Effluent Flowrate (MGD ADWF)	
R-1 50th % concen. (μg/L)*	**61.5**				
Projected effluent concen. (μg/L)	**50**	*600*	*1250*	*9.87*	*17.5*
Estimated mass loading (lbs/day)		199	414	4.1	7.3
Estimated downstream R-3 river concen. (μg/L) at 600 cfs				61.2	61.0
Estimated downstream R-3 river concen. (μg/L) at 1250 cfs				61.4	61.3

* 50th percentile statistic calculated using the following data set:
Data Period: November 2005 – July 2006; Sample Size, n = 10; Percent Detected Data = 60%

Manganese

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to a wet water year were used to calculate an estimated impact of WQCF effluent dissolved manganese in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). Ideally, an R-1 dissolved manganese data set corresponding to dry/below normal water years would be used for the present analysis, but such a data set was not available. Improved WQCF treatment processes are projected to produce treated effluent having an average total manganese concentration of 10 µg/L. For the purpose of the current analysis, and to be conservative, all manganese present in WQCF treated effluent is assumed to be in the dissolved form.

Results: The effect on an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical San Joaquin River flow conditions (600 cfs), an increase in WQCF effluent discharge will slightly decrease dissolved manganese concentration in the San Joaquin River, relative to its Basin Plan objective, downstream of the discharge as shown in **Figure 16** and **Table 22**. Estimated river concentrations associated with dry/below normal flow conditions (1250 cfs) show no measurable change in dissolved manganese concentrations in the San Joaquin River with increasing WQCF effluent discharge. A slight increase in dissolved manganese mass loading to the river is also projected.
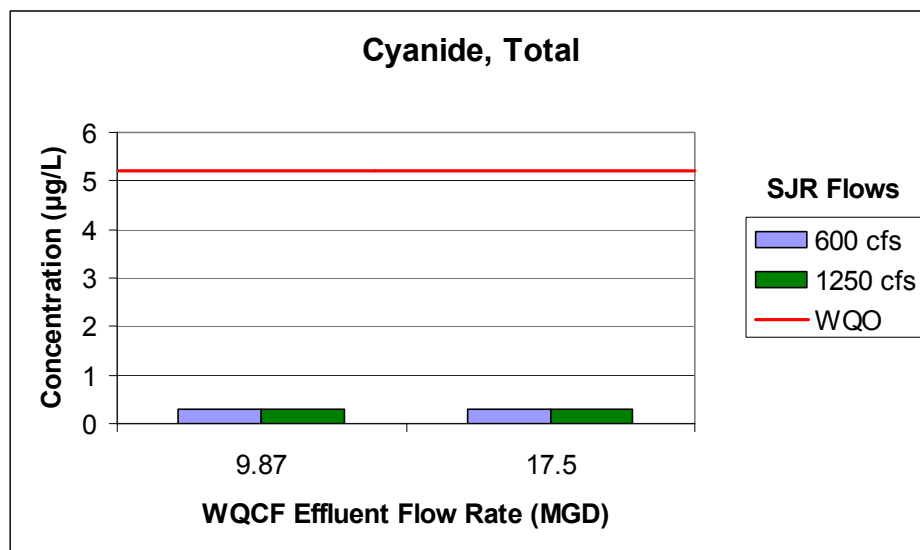

Figure 16: Projected Change in San Joaquin River Dissolved Manganese Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The Basin Plan objective for dissolved manganese for the Delta is 50 µg/L, expressed as the dissolved fraction (Basin Plan, Table III-1). Estimated concentrations of dissolved manganese in the San Joaquin River under critical flow conditions (600 cfs) show a slight decrease, relative to the Basin Plan objective, with an increase in WQCF effluent discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). No measurable change in

dissolved manganese river concentration is projected under dry/below normal flow conditions (1250 cfs) with increasing WQCF discharge. The incremental change in dissolved manganese concentration in the river is slight when increasing the WQCF discharge from the current permitted discharge of 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF) under the critical flow condition. Projected, median dissolved manganese concentrations in the San Joaquin River are well below the Basin Plan objective.

Evaluation: The incremental change in dissolved manganese concentration in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)) manifests as a very slight decrease under critical flow conditions (600 cfs) due to the lower effluent concentration of the dissolved metal relative to the river. No measurable change in the river's dissolved manganese concentrations are projected during flow conditions representative of dry/below normal water years (1250 cfs) as WQCF effluent discharge increases from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The incremental change in the dissolved manganese mass loading to the river is projected to be slight relative to existing in-stream loads. Additionally, projected, median dissolved manganese concentrations in the San Joaquin River are well below the Basin Plan objective.

Table 22: Estimated Impact of Dissolved Manganese from WQCF Discharge in the San Joaquin River at WQCF R-3

Manganese, Dissolved		*San Joaquin River Flowrate (cfs)*		*Manteca WQCF Effluent Flowrate (MGD ADWF)*	
R-1 50th % concen. (μg/L)*	**14.3**				
Projected effluent concen. (μg/L)	**10**	*600*	*1250*	*9.87*	*17.5*
Estimated mass loading (lbs/day)		46	96	0.8	1.5
Estimated downstream R-3 river concen. (μg/L) at 600 cfs				14.2	14.1
Estimated downstream R-3 river concen. (μg/L) at 1250 cfs				14.2	14.2

* 50th percentile statistic calculated using the following data set:
Data Period: November 2005 – July 2006; Sample Size, n = 10; Percent Detected Data = 90%

Methylene Blue Active Substances (MBAS)

Data Availability: A limited methylene blue active substances (MBAS) receiving water data set featuring all non-detected R-1 data was available for this analysis. To that end, an estimated MBAS concentration in the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to dry/below normal water years was used to calculate a projected impact of WQCF effluent MBAS in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). Improved WQCF treatment processes are projected to produce treated effluent having an average MBAS concentration of 160 µg/L.

Results: The effect on an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will slightly increase MBAS concentration in the San Joaquin River, relative to its Title 22 Secondary MCL criterion, downstream of the discharge as shown in **Figure 17** and **Table 23**. The R-1 ambient MBAS concentration employed in the present analysis was estimated using the median method detection limit (MDL) associated with the non-detected data. The median MDL for MBAS from the City's NPDES self-monitoring data is 20 µg/L. A slight increase in MBAS mass loading to the river is also projected from this analysis.

Figure 17: Projected Change in San Joaquin River Methylene Blue Active Substances Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The California Code of Regulation, Title 22 Secondary MCL criterion for MBAS, incorporated into the Basin Plan by reference, is 500 µg/L. Estimated concentrations of MBAS in the San Joaquin River under critical and dry/below normal flow conditions show a slight increase, relative to the Title 22 Secondary MCL, with an increase in WQCF effluent discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The incremental change in MBAS concentration in the river is slight when increasing the WQCF discharge from

the current permitted discharge of 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF). Projected, median MBAS concentrations in the San Joaquin River are well below the Title 22 Secondary MCL standard.

Evaluation: The incremental change in MBAS concentration and mass loading in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)) is slight. Additionally, projected MBAS concentrations in the San Joaquin River are well below the Title 22 Secondary MCL of 500 µg/L.

Table 23: Estimated Impact of Methylene Blue Active Substances from WQCF Discharge in the San Joaquin River at WQCF R-3

Methylene Blue Active Substances (MBAS)		San Joaquin River Flowrate (cfs)		Manteca WQCF Effluent Flowrate (MGD ADWF)	
R-1 estimated concen. (µg/L)*	20				
Projected effluent concen. (µg/L)	160	600	1250	9.87	17.5
Estimated mass loading (lbs/day)		65	135	13.2	23.4
Estimated downstream R-3 river concen. (µg/L) at 600 cfs				23.5	26.1
Estimated downstream R-3 river concen. (µg/L) at 1250 cfs				21.7	23.0

* Statistic derived from the following data set:
Data Period: January 2002 – December 2002; Sample Size, n = 12; Percent Detected Data = 0%

Nitrate

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to dry/below normal water years were used to calculate an estimated impact of WQCF effluent nitrate (as nitrogen) in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). Improved WQCF treatment processes are projected to produce treated effluent having an average nitrate (as nitrogen) concentration of 7 mg/L.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will slightly increase nitrate (as nitrogen) concentration in the San Joaquin River, relative to its Title 22 Primary MCL criterion, downstream of the discharge as shown in **Figure 18** and **Table 24**. A slight increase in nitrate (as nitrogen) mass loading to the river is also projected.
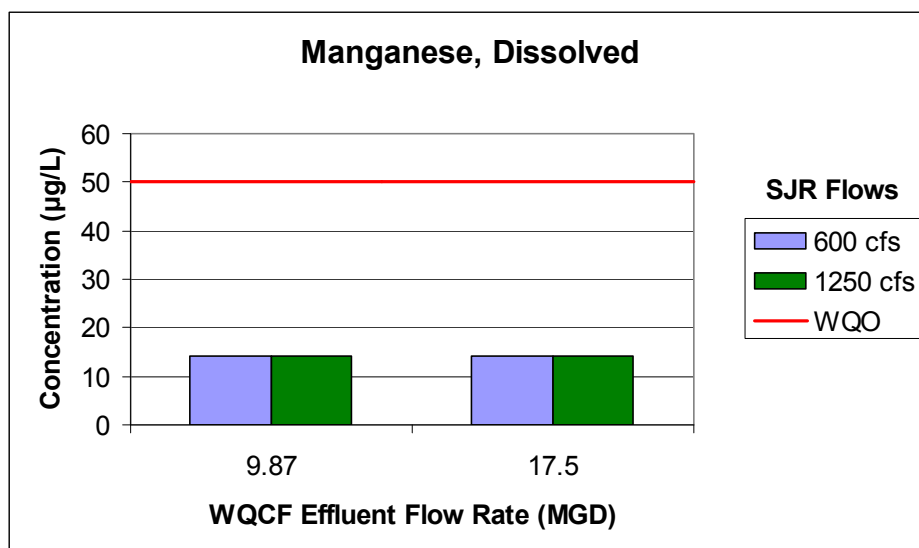

Figure 18: Projected Change in San Joaquin River Nitrate (as Nitrogen) Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The California Code of Regulation, Title 22 Primary MCL criterion for nitrate + nitrite (sum as nitrogen), incorporated into the Basin Plan by reference, is 10 mg/L. This Title 22 Primary MCL is the appropriate and most stringent water quality objective to apply to nitrate (as nitrogen) in the San Joaquin River. Estimated concentrations of nitrate (as nitrogen) in the San Joaquin River under critical and dry/below normal flow conditions show a slight increase, relative to the Title 22 Primary MCL, with an increase in WQCF effluent discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The incremental change in nitrate (as nitrogen) concentration in the river is slight when increasing the WQCF discharge from the current permitted discharge of 9.87 MGD (ADWF) to the proposed

17.5 MGD (ADWF). Projected, median nitrate (as nitrogen) concentrations in the San Joaquin River are well below the Title 22 Primary MCL standard.

Evaluation: The incremental change in nitrate (as nitrogen) concentration in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)) is slight and below the magnitude of change that could be reliably measured in the field. Similarly, the projected increase in nitrate (as nitrogen) mass loading to the river is also slight. Additionally, projected, median nitrate (as nitrogen) concentrations in the San Joaquin River are well below the Title 22 Primary MCL standard of 10 mg/L.

Table 24: Estimated Impact of Nitrate (as Nitrogen) from WQCF Discharge in the San Joaquin River at WQCF R-3

Nitrate as Nitrogen		San Joaquin River Flowrate (cfs)		Manteca WQCF Effluent Flowrate (MGD ADWF)	
R-1 50th % concen. (mg/L)*	2.55				
Projected effluent concen. (mg/L)	7	600	1250	9.87	17.5
Estimated mass loading (lbs/day)		8,247	17,181	412	730
Estimated downstream R-3 river concen. (mg/L) at 600 cfs				2.66	2.74
Estimated downstream R-3 river concen. (mg/L) at 1250 cfs				2.60	2.64

* 50th percentile statistic calculated using the following data set:
Data Period: January 2002 – December 2002; Sample Size, n = 12; Percent Detected Data = 100%

Nitrite

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to dry/below normal water years were used to calculate an estimated impact of WQCF effluent nitrite (as nitrogen) in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). Improved WQCF treatment processes are projected to produce treated effluent having an average nitrite (as nitrogen) concentration of 1 mg/L.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will slightly increase nitrite (as nitrogen) in the San Joaquin River, relative to its Title 22 Primary MCL criterion, downstream of the discharge as shown in **Figure 19** and **Table 25**. The data set used in the present analysis included 83.3% non-detected data, therefore requiring the estimation of an ambient river concentration. The R-1 ambient nitrite (as nitrogen) concentration employed in the present analysis was estimated by setting the ambient level at the method detection limit (MDL) associated with the City's non-detected data. The MDL for nitrite (as nitrogen) from the City's NPDES self-monitoring data is 0.002 mg/L. A slight increase in nitrite (as nitrogen) mass loading to the river is also projected.
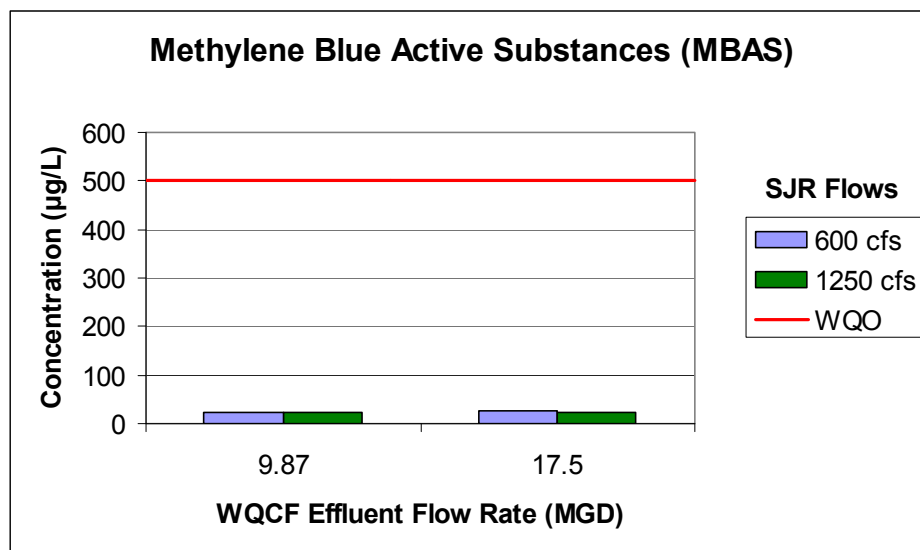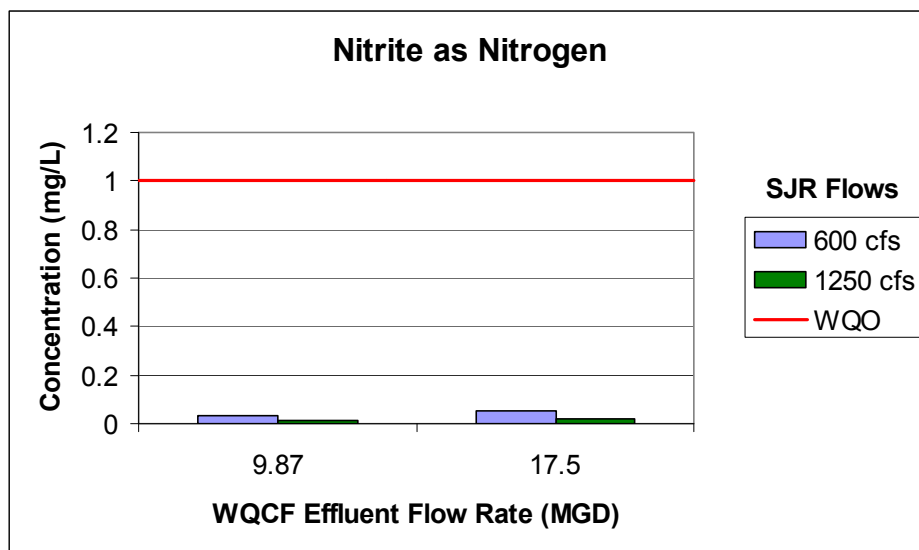

Figure 19: Projected Change in San Joaquin River Nitrite (as Nitrogen) Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The California Code of Regulation, Title 22 Primary MCL criterion for nitrite (as nitrogen), incorporated into the Basin Plan by reference, is 1 mg/L. This Title 22 Primary MCL is the appropriate and most stringent water quality objective to apply to nitrite (as nitrogen) in the San Joaquin River. Estimated concentrations of nitrite (as nitrogen) in the San Joaquin River under critical and dry/below normal flow conditions show a slight increase, relative to the Title 22 Primary MCL, with an increase in WQCF effluent

discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The incremental change in nitrite (as nitrogen) concentration in the river is slight when increasing the WQCF discharge from the current permitted discharge of 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF). Projected, median nitrite (as nitrogen) concentrations in the San Joaquin River are well below the Title 22 Primary MCL standard.

Evaluation: The incremental change in nitrite (as nitrogen) concentration and mass loading in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)) is slight. A high level of nitrogen removal has been accomplished through the activated sludge nitrification-denitrification process implemented as one of several treatment process improvements associated with the WQCF upgrade. Additionally, projected, median nitrite (as nitrogen) concentrations in the San Joaquin River are well below the Title 22 Primary MCL standard of 1 mg/L.

Table 25: Estimated Impact of Nitrite (as Nitrogen) from WQCF Discharge in the San Joaquin River at WQCF R-3

Nitrite as Nitrogen		*San Joaquin River Flowrate (cfs)*		*Manteca WQCF Effluent Flowrate (MGD ADWF)*	
R-1 estimated concen. (mg/L)*	**0.002**				
Projected effluent concen. (mg/L)	**1**	*600*	*1250*	*9.87*	*17.5*
Estimated mass loading (lbs/day)		6	13	82.3	146
Estimated downstream R-3 river concen. (mg/L) at 600 cfs				0.03	0.05
Estimated downstream R-3 river concen. (mg/L) at 1250 cfs				0.01	0.02

* Statistic derived from the following data set:
Data Period: January 2002 – December 2002; Sample Size, n = 12; Percent Detected Data = 16.7%

Mercury

Data Availability: Manteca WQCF NPDES self-monitoring data from the San Joaquin River at R-1 (just upstream of the WQCF discharge) corresponding to dry/below normal water years were used to calculate an estimated impact of WQCF effluent total mercury in the San Joaquin River under critical (600 cfs) and dry/below normal (1250 cfs) river flows at a permitted discharge of 9.87 MGD (ADWF) and at a proposed discharge of 17.5 MGD (ADWF). Advanced WQCF treatment processes recently installed at the WQCF have been producing treated effluent having an average total mercury concentration of 0.01 µg/L.

Results: The effect of an increase in WQCF discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) is appropriately addressed in the receiving water at well-mixed conditions downstream of the discharge. During critical and dry/below normal San Joaquin River flow conditions, an increase in WQCF effluent discharge will slightly increase total mercury concentration in the San Joaquin River, relative to its CTR objective, downstream of the discharge as shown in **Figure 20** and **Table 26**. A slight increase in total mercury mass loading to the river is also projected.
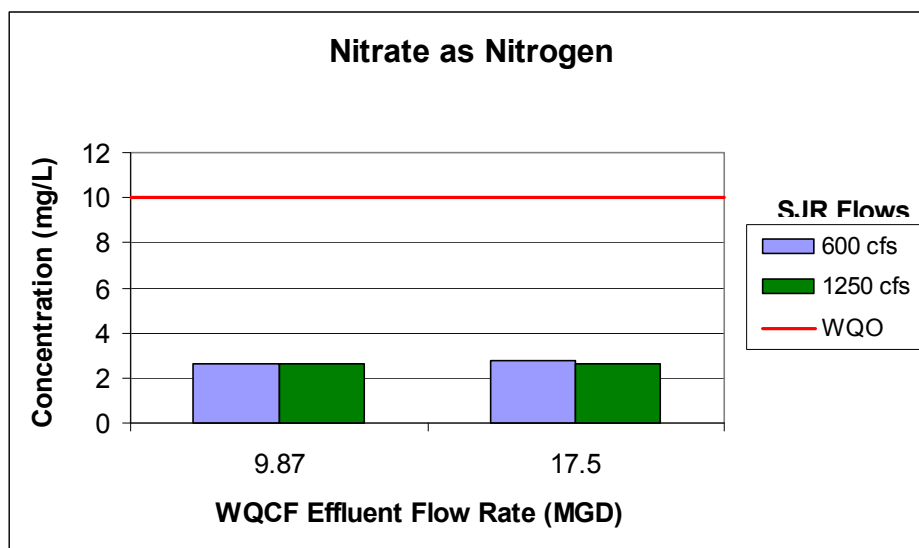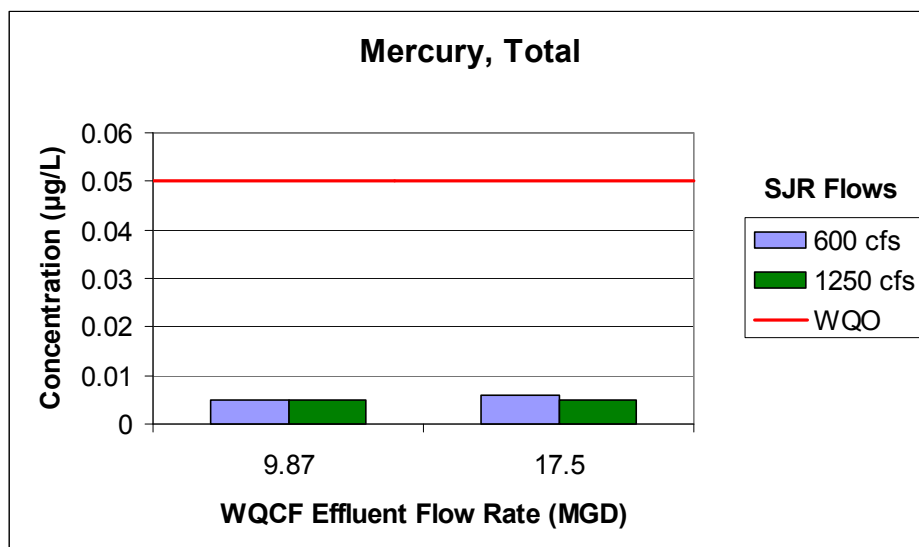

Figure 20: Projected Change in San Joaquin River Total Mercury Concentration at WQCF R-3 with increasing WQCF Effluent Flowrate

Comparison to Water Quality Objective: The CTR Human Health (water and organisms) objective for total mercury as it applies to the San Joaquin River is 0.05 µg/L. Estimated concentrations of total mercury in the San Joaquin River under critical and dry/below normal flow conditions show a slight increase, relative to the CTR Human Health objective, with an increase in WQCF effluent discharge from 9.87 MGD (ADWF) to 17.5 MGD (ADWF). The incremental change in total mercury concentration in the river is slight when increasing the WQCF discharge from the current permitted discharge of 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF). Projected, median total mercury in the San Joaquin River are well below the CTR Human Health (water and organisms) objective.

Evaluation: The incremental change in total mercury concentration in the San Joaquin River due to an increase in WQCF effluent discharged from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)) is slight and below the magnitude of change that could be reliably measured in the field. Additionally, projected, median total mercury concentrations in the San Joaquin River are well below the CTR Human Health (water and organisms) criterion of 0.05 µg/L. It should be recognized that the estimated mass loading (lbs/day) of total mercury in the San Joaquin River at a WQCF effluent flowrate of 17.5 MGD (ADWF) produces a load (0.53 lbs/year) lower than the currently permitted 0.69 lbs/year based on a WQCF treatment design capacity of 9.87 MGD (ADWF).

With respect to the Sacramento-San Joaquin Delta Mercury TMDL, the establishment of a future waste load allocation (WLA) and future mass limit for the WQCF will need to consider all existing mercury inputs in the watershed in order to develop an appropriate WLA that provides the intended level of protection to the beneficial uses of the San Joaquin River. Upon review of the methylmercury data generated from the 2004-2005 Central Valley Clean Water Agency Mercury Study (Pirondini, 2006), it is anticipated that future methylmercury levels in WQCF tertiary treated effluent should not exceed, on average, the 0.06 ng/L methylmercury implementation goal set forth in the draft Sacramento-San Joaquin Delta Methylmercury TMDL (CVRWQCB, 2006a).

Table 26: Estimated Impact of Total Mercury from WQCF Discharge in the San Joaquin River at WQCF R-3

Mercury, Total		San Joaquin River Flowrate (cfs)		Manteca WQCF Effluent Flowrate (MGD ADWF)	
R-1 50th % concen. (µg/L)*	0.005				
Projected effluent concen. (µg/L)	0.01	600	1250	9.87	17.5
Estimated mass loading (lbs/year)		6.35	13.23	0.30	0.53
Estimated downstream R-3 river concen. (µg/L) at 600 cfs				0.005	0.006
Estimated downstream R-3 river concen. (µg/L) at 1250 cfs				0.005	0.005

* 50th percentile statistic calculated using the following data set:
Data Period: January 2002 – September 2004; Sample Size, n = 14; Percent Detected Data = 100%

Temperature

Preparation of the 2007 Draft Environmental Impact Report for the WQCF Phase IV/V
Expansion Project (EDAW, 2007) revealed that the WQCF effluent would not comply with all
objectives of the *Water Quality Control Plan for Control of Temperature in the Coastal and
Interstate Waters and Enclosed Bays and Estuaries of California* (Thermal Plan; SWRCB, 1972)
under some conditions. Because the WQCF outfall is an existing discharge in the tidally
influenced reach of the San Joaquin River, Section 5.A of the Thermal Plan applies to the
discharge and stipulates the following:

> (1) Elevated temperature waste discharges shall comply with the following:
>> a. The maximum temperature shall not exceed the natural receiving water
>> temperature by more than 20°F.
>> b. Elevated temperature waste discharges either individually or combined
>> with other discharges shall not create a zone, defined by water
>> temperatures of more than 1°F above natural receiving water temperature,
>> which exceeds 25 percent of the cross-sectional area of a main river
>> channel at any point.
>> c. No discharge shall cause a surface water temperature rise greater than 4°F
>> above the natural temperature of the receiving waters at any time or place.

In general, the WQCF effluent is warmer than the San Joaquin River during fall, winter, and
spring months; and if evaluated on a monthly average, objective a. of the Thermal Plan is met for
the WQCF discharge. Because the effluent is warmer than the receiving water, objectives b. and
c. of the Thermal Plan are not necessarily met within the WQCF plume. A three-dimensional,
hydrodynamic RMA-10 model of the river run in the vicinity of the WQCF discharge was used
to evaluate the thermal plume corresponding to WQCF flowrates of 8.11, 9.87, 17.5, and 27
MGD (RMA, 2006). The model simulated atmospheric heat exchange using the meteorological
data from nearby monitoring sites as inputs, and was calibrated and validated using historic data
and recent field measurements. Model results revealed that even operating under a schedule for
timed discharge during periods of low river flow discharging only on the outgoing tide, the
thermal plume may not meet objective 5.A(1).b of the Thermal Plan above WQCF flowrates of
9.87 MGD and critical low receiving water flowrates. The temperature difference between the
discharge and the river may exceed objective 5.A(1).c of the Thermal Plan during periods of the
year regardless of timed discharge or effluent and river flowrates.

The Phase IV expansion will include cooling facilities sufficient for the WQCF discharge and
thermal plume to comply with the three applicable provisions. As part of the requested capacity
increase the City wishes to define the river and environmental conditions when the operation of
cooling facilities is not necessary to maintain a negligible impact on Salmonids. Generally, as
the river flowrate increases, the relative size of the discharge plume is reduced thus reducing the
potential for a thermal impact. Unnecessary operation of cooling facilities will result in
unneeded power consumption and associated increases in greenhouse gas emissions. At greater
river flowrates, the discharge at 17.5 MGD will comply with provision 5.A(1)b, in that there will
be a resulting temperature differential above ambient of 1ºF over less than 25% of the channel
cross section. Without cooling, the discharge may not comply with provision 5.A(1)c because
the effluent may be greater than 4ºF above the ambient river temperature. However, at increased

river flowrates the area in the river exceeding provision 5.A(1)c will be greatly reduced. The City initiated a modeling investigation to evaluate the river flowrates necessary to result in a thermal plume complying with provision 5.A(1)b, and coupled with the consideration of aquatic species present has reevaluated the exception request to include ambient conditions and seasons where there is negligible impact on aquatic species.

Modeling Approach: The Cornell Mixing Zone Expert System (CORMIX) model is used to model the dilution characteristics of the WQCF outfall discharge into the San Joaquin River. CORMIX is designed to evaluate geometry and flow input for the river and discharge to internally select an appropriate modeling strategy. Selection of CORMIX to model the WQCF outfall is based on ease-of-use, ability to model deep and shallow water discharges, ability to model thermal discharges, and flexibility in modeling discharge characteristics. CORMIX is approved and recommended by the U.S. EPA for modeling mixing zones.

Because the river flowrate necessary to result in a thermal plume complying with provision 5.A(1)b of the Thermal Plan is elevated above the low flow conditions evaluated with the 3-D model, and because the WQCF discharge is near the furthest extent of the tidal influence, the tidal effects are greatly diminished allowing the use of the CORMIX model to simulate the thermal plume. Furthermore, because the elevated river flowrates considered are sufficient to maintain positive downstream flow, there is no need for intermittent discharge, again allowing CORMIX to adequately model the thermal plume.

The objectives of the analysis described herein are to define the river flowrates where the 17.5 MGD discharge will comply with provision 5.A(1)b, evaluate the area of the river potentially exceeding 5.A(1)c, and consider when Salmonid adults and smolts may be present at the point of discharge and how the discharge may affect their behavior. The result of the analysis is a refined Thermal Plan exception request based on the ambient river conditions necessary so that the discharge will have negligible thermal impact on Salmonids passing the discharge.

The model was used to evaluate three critical seasonal scenarios: Fall, Winter, and Spring for the critical and dry/below normal river flowrates. During these seasons anadromous fish are in the river, either migrating upstream as adults or emigrating downstream as juveniles. Because there is no single most critical condition for evaluating the thermal impact of the WQCF plume, all three of the conditions identified above have been evaluated (LWA, 2008).

Results: At elevated river flowrates, the tidal influence is reduced so that the differences in ambient conditions between seasons are best represented by typical temperature differentials between the effluent and receiving water. Generally, as the temperature differential between effluent and receiving water increases, a greater receiving water flowrate is necessary to comply with Thermal Plan provision 5.A(1)b. A chart representing receiving water flowrate required to comply with provision 5.A(1)b as a function of the temperature differential between effluent and receiving water is presented in **Figure 21**. For a given temperature differential, if the receiving water flowrate is greater than that indicated by the curve on **Figure 21**, then the thermal plume will conform with Thermal Plan provision 5.A(1)b.

In Fall and Winter, the adult Salmonids are migrating upstream and are unlikely to be affected by the floating thermal plume conforming with provision 5.A(1)b. Furthermore, the adult Salmonids generally avoid the high current areas of the cross section, so they are unlikely to migrate along the bank past the WQCF discharge. In spring when smolts are migrating

downstream the cooling facilities would be operated unless the river flowrate was great enough to submerge the outfall, as the smolts generally follow the bank. Under the conditions listed in **Table 27**, the ambient conditions are sufficient to result in no non-negligible thermal impacts to the Salmonid species and life stages present in the river, and therefore the City is requesting limited exceptions from the Thermal Plan provisions as listed in **Table 27**.
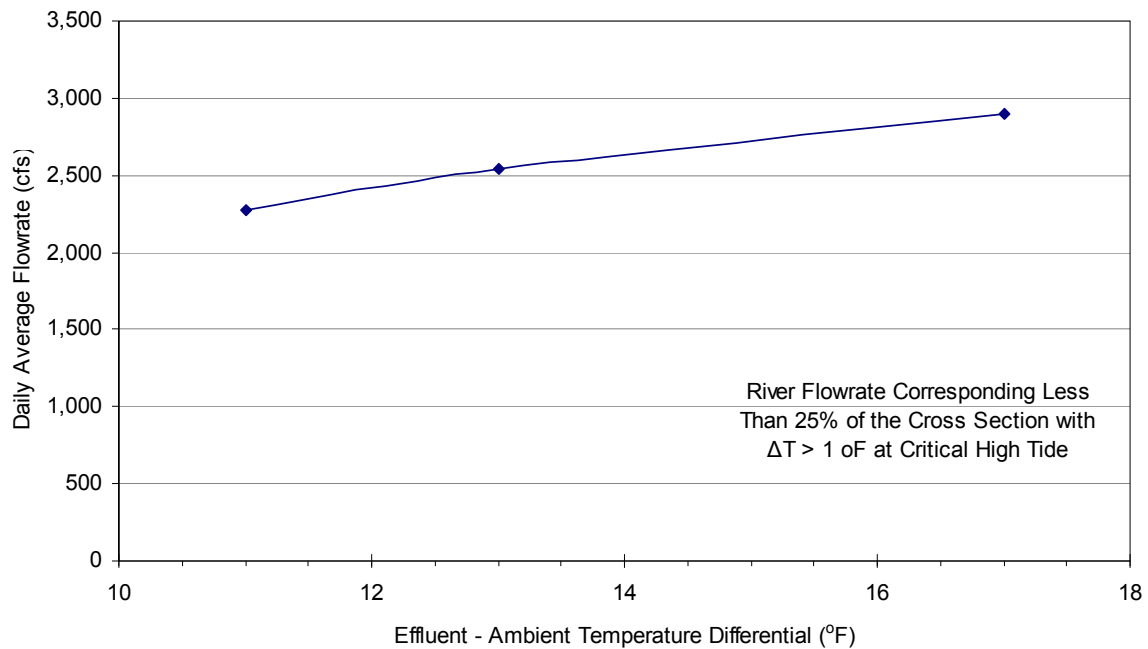
Figure 21: San Joaquin River Flowrate for 1°F Temperature Differential in Less Than 25% of the Channel Cross Section at High Tide for a Range of Initial Effluent to Ambient Temperature Differentials for an Effluent Flowrate of 17.5 MGD.

Table 27: Summary of CORMIX Thermal Modeling Results for WQCF Discharge Flowrate of 9.87 MGD and Corresponding Conditions for Thermal Plan Exception Request and Suspension of Cooling Facilities Operation. (✓ = Compliance, E = Exception Requested)

Season	Sensitive Aquatic Life	River Flowrate (cfs)	Cooling Facilities Operating	Thermal Plan Compliance 5.A(1).		
				a	b	c
Fall (Sep-Nov)	Adult Salmon	<2,600	Y	✓	✓	✓
		>2,600	N	✓	✓	E
Winter (Dec-Feb)	Adult Steelhead	<2,900	Y	✓	✓	✓
		>2,900	N	E[(i)]	✓	E
Spring (Mar-May)	Salmonid Smolts	<12,000[(ii)]	Y	✓	✓	✓
		>12,000	N	✓	✓	E
Summer (Jun-Aug)	None	NA	N	✓	✓	✓

(i) The City requests that provision 5.A(1)a of the Thermal Plan be evaluated as a monthly average when cooling is not necessary to meet provision 5.A(1)b of the Thermal Plan.

(ii) The outfall is submerged corresponding to river flowrates greater than 12,000 cfs.

Comparison to Water Quality Objectives: The thermal plume from the 9.87 MGD (ADWF) discharge does not comply with all objectives of the Thermal Plan. The analysis of the thermal plume reveals that the temperature differential between the effluent and the river may slightly exceed 20ºF for brief periods, but utilizing timed discharge during periods of low river flow a 1ºF differential is limited to less than 25% of the river's cross section. Additionally, there is a limited zone where the temperature differential exceeds 4ºF. However, the fisheries analysis of the thermal plume revealed that there would be no significant impact on sensitive fish species and the impact would be limited to avoidance behavior of migrating salmonids (LWA, 2006a). A request to evaluate objective 5.A(1)a as a monthly average, and an exception limited to objective 5.A(1)c is being sought to provide relief and allow compliance with the Thermal Plan.

An informal consultation with the National Marine Fisheries Service (NMFS) Protected Resource Division was initiated by the RWQCB to assess the exception request. Without a formal action by the RWQCB, the NMFS review is limited to an informal consultation where only projects with no non-negligible impacts can receive approval. The exception request acknowledged that there may be resulting small behavioral impacts to Salmonids, so the NMFS informal consultation could not result in an approval. A formal consultation would trigger a critical review of the exception request and evaluation of the potential for a take of sensitive species. To date the formal consultation has not been performed.

With respect to the WQCF side bank discharge, increasing the discharge rate above 9.87 MGD (ADWF) will result in the required 1ºF temperature differential over less than 25% of the cross section provision of the Thermal Plan to be exceeded at low receiving water flowrates. As the discharge rate is increased the zone of water greater than 4ºF above ambient river temperature grows laterally and vertically; and extends further downstream. To meet the Thermal Plan objectives at low receiving water flowrates, the City is incorporating cooling facilities into the

proposed Phase IV Expansion Project. The cooling facilities will be designed to bring the WQCF effluent within 4ºF of the ambient river which is sufficient to meet all three applicable provisions of the Thermal Plan. The City is requesting to operate the cooling towers only for river flowrates and temperature differentials where provision 5.A(1)b would not be met, as per the schedule in **Table 27**.

In the Fall and Winter when adult Salmonids may be present in the vicinity of the WQCF discharge and the receiving water flowrate is sufficient to result in the WQCF thermal plume complying with the Thermal Plan provision 5.A(1)b as listed in **Table 27**, the City is requesting an exception from Thermal Plan provision 5.A(1)c as there may be a small area where the temperature differential is greater than 4ºF. Furthermore, for Winter conditions listed in **Table 27**, the City is requesting Thermal Plan provision 5.A(1)a be interpreted as a monthly average. In Spring, when Salmonid smolts may be present along the shoreline, the City is requesting an exception from Thermal Plan provision 5.A(1)c, when the river flowrate is greater than 12,000 cfs and the outfall is fully submerged. Otherwise, the City intends to provide cooling necessary to comply with Thermal Plan provisions.

Evaluation: The Thermal Plan objectives are slightly exceeded for a discharge of 9.87 MGD (ADWF); however, an evaluation of the impacts of the thermal plume reveals that there are no significant impacts of the plume and a limited exception is being sought for the WQCF. Because the threshold for NMFS informal consultation is no non-negligible impacts, the exception for a 9.87 MGD discharge rate has not been granted. Increasing the effluent flowrate will increase the thermal plume, resulting in exceedance of both the 1ºF temperature differential over less than 25% of the cross section, and 4ºF differential anywhere objectives in the Thermal Plan. Because the Thermal Plan objectives are exceeded, the City is intending to design, construct, install, and operate cooling facilities sufficient to maintain no non-negligible thermal impacts to aquatic life in the San Joaquin River. The cooling facilities would be confirmed to perform at final design specifications prior to operation of the WQCF at the proposed expanded capacity.

Implementation of cooling facilities would sufficiently reduce the modeled thermal impacts of the WQCF's non-cooled effluent plume resulting in no significant adverse thermal effects on fisheries and aquatic resources as a result of the planned increase in WQCF discharge capacity from the current permitted rate (9.87 MGD (ADWF)) to the proposed rate (17.5 MGD (ADWF)). As the effluent will be cooled as necessary to comply with the Thermal Plan provisions during periods of low river flowrate, the timed discharge schedule would no longer be necessary. The City proposes to maintain the timed discharge until the cooling facilities are operational.

The City performed investigative modeling to determine an operation envelope where the ambient river conditions would be sufficient to mitigate the WQCF thermal plume and result in non-negligible impacts to sensitive aquatic life without the use of cooling facilities. As part of the current ROWD submittal, the City is requesting a limited exception from applicable Thermal Plan provisions under ambient conditions and seasons where the resulting plume will have a negligible impact on sensitive aquatic life (Salmonids). Depending on the difference in temperature between the ambient river and effluent, at an effluent flowrate of 17.5 MGD, a river flowrate between 2,000 and 3,000 cfs is sufficient for the effluent to comply with provision 5.A(1)b of the Thermal Plan as detailed in **Table** 27. However, it was found that a river flowrate of greater than 12,000 cfs was necessary to submerge the outfall. Specifically, the City would request exception from the Thermal Plan provisions 5.A(1)a and 5.A(1)c in the Fall and Winter

when the river flowrate was sufficient to provide compliance with 5.A(1)b, as the adult salmon and steelhead would be migrating up river along the channel bottom unaffected by the floating WQCF thermal plume. When river flowrates in the Spring exceed 12,000 cfs and the outfall is submerged, the City would request exception from Thermal Plan provision 5.A(1)c as the smolts would not likely encounter the initial mixing zone where water temperature differentials may be greater than 4ºF.

Whole Effluent Toxicity Summary

As a means of assessing the potential for the proposed 7.63 MGD (ADWF) discharge capacity increase to adversely impact toxicity in the San Joaquin River, a review of the WQCF's whole effluent toxicity data was conducted. The City is required by its NPDES permit to test its effluent on a regular basis to determine acute and chronic toxicity of its effluent. As treatment facility upgrades have been constructed during the Phase III expansion, the WQCF's effluent quality has been improving with the current level of treatment consisting of nitrification-denitrification, filtration, and UV disinfection. As a result of current treatment practices the presence of contaminants such as ammonia and chlorine residual, which may have historically contributed to elevated toxicity levels, have been greatly reduced.

Acute effluent toxicity is tested monthly on fathead minnow (*Pimephales promelas*) as percent survival after 96-hour exposure in 100% WQCF effluent. The City's current permit establishes a limit of 70% survival for any single bioassay result and a median result of 90% survival for any three consecutive bioassays. Bioassay results for test conducted in WQCF undiluted effluent have always exceeded these survival rates. Since the beginning of the current NPDES permit cycle, between April 2004 and December 2007, 44 acute toxicity tests were performed. The acute toxicity results showed 100% survival in 100% effluent for 40 out of the 44 tests. Of the four results that showed less than 100% survival, two exhibited 95% survival, one presented 90% survival, and one revealed 80% survival in WQCF effluent. For each instance of less than 100% survival, the next scheduled test had a 100% survival result and median survival rates for three consecutive bioassays were always greater than 90%. No test with less than 100% survival has been observed since April 2005. In the period following introduction and stabilization of nitrification-denitrification facilities starting in July 2006, monthly acute toxicity testing has revealed no observed toxicity in WQCF effluent.

Required quarterly chronic toxicity tests include the following: 4-day algal growth (*Selanastrum capricornutum*), 7-day *Ceriodaphnia dubia* survival and reproduction, and 7-day larval *Pimephales promelas* (fathead minnow) survival and growth. These tests are run on mixtures of 6.25%, 12.5%, 25%, 50%, and 100% effluent. Chronic IC25 testing results for the period July 2006 through December 2007 were all <1 as TUc (100/IC25) for fathead minnow survival and growth tests. With the exception of two 4 TUc results from July and September 2006, test results for *Ceriodaphnia dubia* survival and reproduction have not been observed to exceed 1 TUc. The third species evaluated for chronic toxicity, the algae *Selanastrum capricornutum*, has experienced occasional NOEC results of 4 TUc, with the vast majority of tests showing NOEC values of 1 or 2 TUc (see **Table 28**).

The City's effluent receives a chronic dilution of 4 to 1 in the San Joaquin River, and therefore chronic toxicity testing from the 18 months of available data following addition of nitrification-denitrification processes indicates that the City's effluent has no adverse impact on the receiving water. Additionally, WQCF effluent quality has consistently been improving with the addition

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of filtration and UV disinfection beginning in September 2007. Considering that the City's effluent will maintain this high water quality throughout and after implementation of the proposed project, it is projected that an increase in discharge from the current 9.87 MGD (ADWF) to the proposed 17.5 MGD (ADWF) will produce no adverse toxic effects in the receiving water.

Table 28: WQCF Chronic Toxicity Test Results (TUc) – July 2006 to December 2007

Date	Selanastrum		Ceriodaphnia Survival		Ceriodaphnia Reproduction		Fathead Minnow Survival		Fathead Minnow Growth	
	NOEC	IC25	NOEC	IC25	NOEC	IC25	NOEC	IC25	NOEC	IC25
Jul-06	4	3.4	1	<1	4	10.1	1	<1	1	<1
Aug-06	1	1.3	1	<1	1	<1	---	---	---	---
Sep-06	1	<1	1	<1	4	5.6	---	---	---	---
Oct-06	2	1.6	1	<1	1	<1	1	<1	1	<1
Nov-06	2	2	1	<1	1	1.4	---	---	---	---
Dec-06	2	1.8	1	<1	1	<1	---	---	---	---
Jan-07	2	1.6	1	<1	1	<1	1	<1	1	<1
Feb-07	1	<1	---	---	---	---	---	---	---	---
Mar-07	2	1.5	---	---	---	---	---	---	---	---
Apr-07	4	2.3	1	<1	1	<1	1	<1	1	<1
May-07	4	2.7	---	---	---	---	---	---	---	---
Jun-07	1	<1	---	---	---	---	---	---	---	---
Jul-07	1	<1	1	<1	1	<1	1	<1	1	<1
Aug-07	1	<1	---	---	---	---	---	---	---	---
Oct-07	4	2.6	1	<1	1	<1	1	<1	1	<1
Nov-07	1	<1	---	---	---	---	---	---	---	---
Dec-07	2	<1	---	---	---	---	---	---	---	---

FAR-FIELD METHODOLOGY

The far-field water quality effects of the currently permitted WQCF design capacity (9.87 MGD (ADWF)) and the proposed WQCF design capacity phased increases of 17.5 MGD (ADWF) are calculated using a mass balance model in conjunction with a hydrologic model of water movement through the Sacramento-San Joaquin River Delta (RMA, 2006).

Far-Field Analysis and Results

The fraction or percentage of WQCF effluent present at various locations within the Delta was modeled in order to provide an indication of the far-field impacts of the proposed project on Delta water quality. Six locations within the Delta (see **Figure 3** and **Figure 26**) were chosen as far-field sites for the evaluation of water quality impacts due to increased WQCF discharge. Sites were selected to provide pre- and post-project water quality estimates at several drinking water export locations and the DWSC. Due to the limited availability of concurrent water

quality data sets at the various Delta locations of interest, only EC, nitrate, DOC, and DO were selected for far-field analysis. EC is a useful water quality parameter because it serves as a surrogate for salts, while nitrate and DOC are constituents of concern for the treatment of drinking water. To estimate far-field EC, nitrate, and DOC concentrations, the Delta hydrologic model is used to calculate the percent contribution of WQCF effluent at the various Delta locations. DO is treated separately from the other constituents in the current analysis because the physical transfer of oxygen from the atmosphere and the biological consumption of oxygen during respiration greatly affect the concentration of DO. DO cannot be considered conservative, and the area of greatest concern for this parameter is the DWSC. The calculated effluent fractions facilitate the use of a mass balance model to estimate changes in the selected water quality parameters due to an increase in WQCF discharge. Historic Delta water quality data and historic Manteca effluent data are then used to estimate water quality in the Delta following completion of the proposed WQCF Phase IV Expansion Project.

Dissolved Oxygen

The City's proposed project is designed to limit dissolved oxygen impacts in downstream waters to the maximum extent practicable. The proposed project includes nitrification, denitrification, and filtration and produces effluent with a low carbonaceous and nitrogenous oxygen demand.

Two important aspects of DO in the San Joaquin River should be analyzed as WQCF discharge to the river increases: (1) the change in DO at the DWSC, and (2) the minimum DO concentration downstream of the outfall, considering the ambient conditions above the outfall and the characteristics of the WQCF effluent (i.e. an oxygen sag analysis).

DO concentrations in the DWSC are historically subject to severe depression under low river flow conditions that may result in a DO concentration below the minimum objective of 5 mg/L. In January 2005, the Central Valley Regional Water Quality Board (Regional Board) adopted a Total Daily Maximum Load (TMDL) for DO in the Stockton DWSC. Because of sufficiently large data gaps leading to an unresolved linkage analysis, the TMDL was adopted with a phased implementation allowing the needed field and modeling studies to be performed by December 2009 before revisiting the waste load and load allocations for specific sources.

The minimum DO concentration downstream of the WQCF outfall is important to investigate because the full expression of oxygen demand, with the deepest sag in DO concentrations, is potentially far downstream from the WQCF.

Modeling Approach DWSC DO: To evaluate the DO concentrations in the DWSC due to the proposed project, the modeling approach of the 2000 Draft Environmental Impact Report for the WQCF Phase IV Expansion Project (2000 DEIR; EDAW 2000) was extended to consider the increased discharge of the current proposed project. The DO simulations performed for the 2000 DEIR were designed to determine the expected change in conditions in the ship channel and turning basin. To investigate DO, a dynamic link-node modeling system was used to calculate the impact of increasing WQCF plant capacities and level of treatment on DO in the DWSC. In the analysis, the base case effluent condition for the modeling was 6.0 MGD (ADWF) with 20 mg/L for BOD_5 and 22 mg/L as N ammonia. Two phases were considered for the Manteca expansion: 8.11 MGD (ADWF) plant capacity and 9.87 MGD (ADWF). Both cases included advanced treatment resulting in effluent concentrations of 20 mg/L for BOD_5 and 2.0 mg/L as N for ammonia. The incremental change in DO was calculated by sequentially running the model for the base case and the two phases; and subtracting the DO results for the DWSC. To recreate the regression model, the concentrations and flows used in the 2000 DEIR are represented here. The differences in loading between the 2000 DEIR and the discharge scenarios are used to calculate the expected difference in DWSC DO.

In the analysis, the predicted differences in DWSC DO concentrations were due to the differences in loading of oxygen-affecting compounds from the two effluent flowrates. For the model, investigators assumed a BOD_5 to BOD_{ult} factor of 2.5. The investigation did not model the nitrogen cycle explicitly. Instead, an assumed ammonia-to-BOD_{ult} factor of 4.57 was applied in the model.

In the 2000 DEIR, the difference in DWSC DO was calculated in response to increasing Manteca effluent discharge rates from 6.0 to 8.11 MGD (ADWF), and from 6.0 to 9.87 MGD (ADWF). At the 6 MGD discharge condition which existed during the data collection and evaluation phase of the TMDL development, the WQCF consisted of secondary level of treatment and the concentration of BOD_{ult} was 151 mg/L due to the ammonia concentration of 22 mg/L as N typical of the discharge. For the 8.11 and 9.87 MGD (ADWF) cases, the conversion factors allowed the total Manteca effluent BOD_{ult} concentration to be calculated as $BOD_{ult} = 20$ mg/L (2.5) + 2.0 mg/L (4.57) = 59.1 mg/L. In moving from the 8.11 MGD condition to the 9.87 MGD condition, the City added filtration, reducing the 5-day BOD from approximately 20 mg/L to 7 mg/L, allowing the total ultimate oxygen demand to be calculated as $BOD_{ult} = 7$ mg/L (2.5) + 1.5 mg/L (4.57) = 24 mg/L. Combining the BOD_{ult} concentration with the effluent flowrate yields the load of total ultimate biological oxygen demand (TUBOD) discharged to the San Joaquin River. The effluent load of total ultimate oxygen demand discharged by the WQCF is presented graphically as a function of ADWF in **Figure 22**. As seen in the figure, the TUBOD load in the WQCF effluent to the San Joaquin River at the proposed 17.5MGD discharge condition is lower than the TUBOD load corresponding to the DWSC baseline condition.
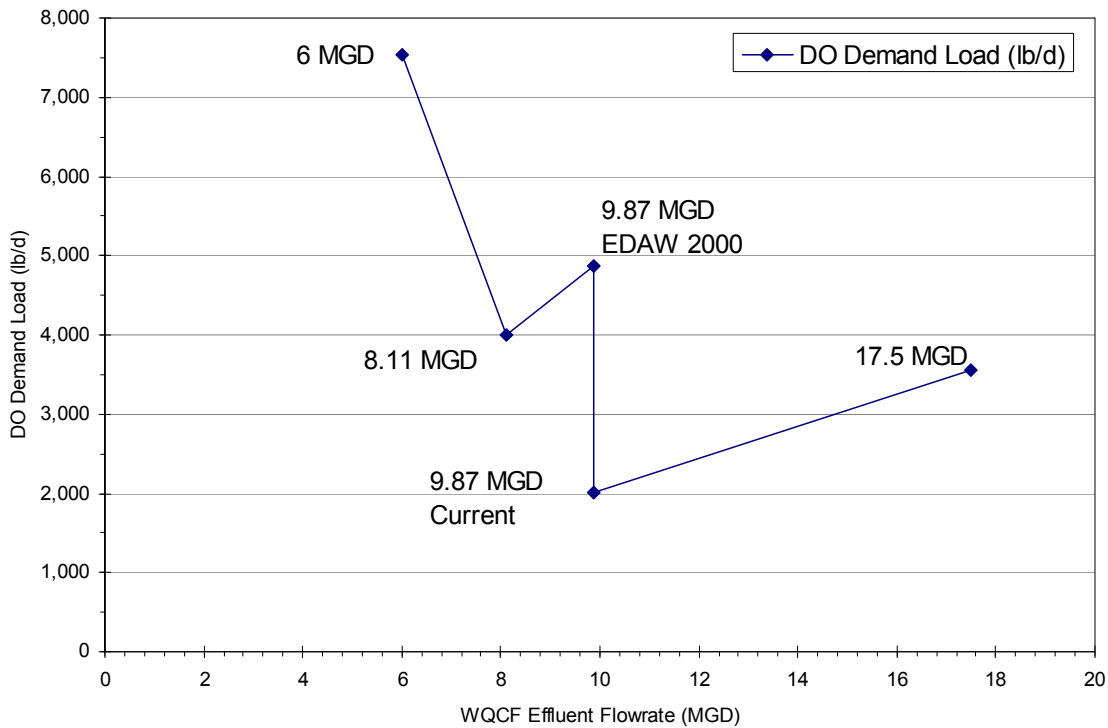
Figure 22: Ultimate Load of Dissolved Oxygen Demand from the WQCF for increasing ADWF (San Joaquin River DO Demand Load at R1 is 92,600 lb/d at 1,250 cfs)

From the near-field analysis, the San Joaquin River at R1 BOD_5 is 5.26 mg/L and the summer and winter ammonia concentrations are 0.13 and 0.08 mg/L as N, respectively. The corresponding total ultimate load carried by the San Joaquin River upstream of the WQCF is 92,600 lb/d in the summer and 91,100 lb/d in the winter for the dry/below normal river flowrate of 1,250 cfs.

Because the link between WQCF discharge and the water quality in the DWSC is not direct and is influenced by natural (tides) and anthropogenic (barrier operation, dam releases) mechanisms, the model was run for 6.0, 8.11, and 9.87 MGD (ADWF) discharge conditions and the paired outputs were used to form a regression between the modeled change in DWSC DO corresponding to the change in WQCF load of total ultimate oxygen demand. The regression equation is used to evaluate the future change in DWSC DO due to the proposed project. A multivariate regression equation was developed to relate the initial DWSC DO and the change in total ultimate oxygen demand to the change in DWSC DO. The regression model has essentially an $r^2 = 1.0$ and a corresponding p-value less than 0.0001, which allows the conclusion to be drawn that the model used here is equivalent to the model used in the 2000 DEIR. The original model results from EDAW 2000 are plotted along with the new regression model in **Figure 23**.
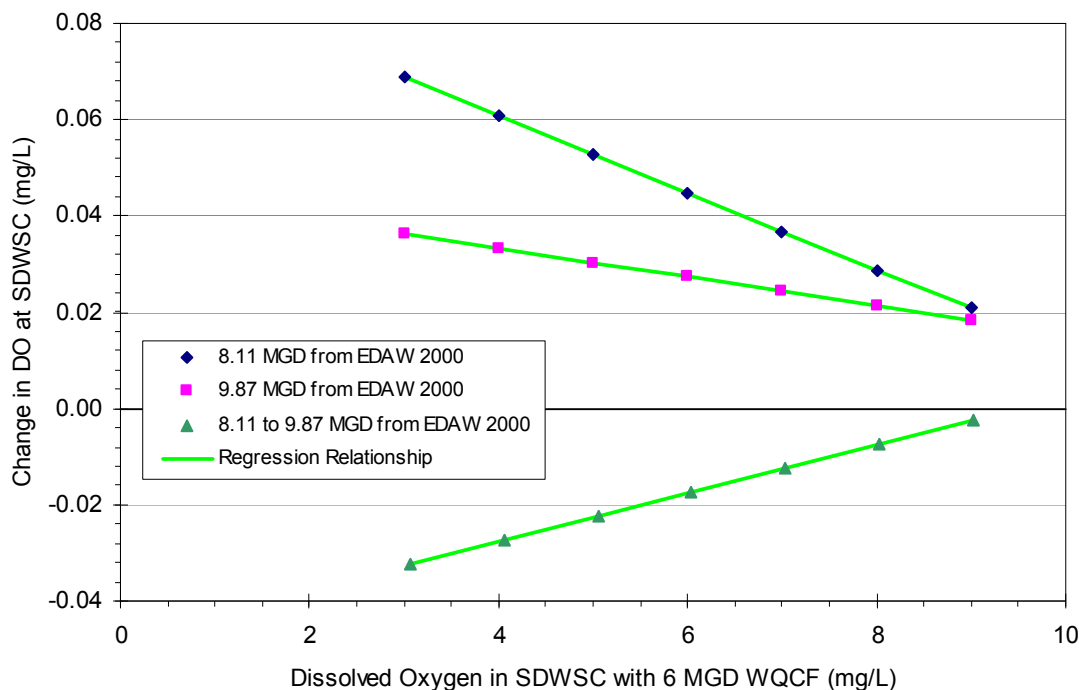
Figure 23: EDAW 2000 Calculated Change in DWSC DO and Corresponding Regression Model

The regression model is as follows:

$$\Delta DO_{DWSC} = 6.43 \times 10^{-9} \cdot (\Delta TUBOD)^2 - 1.5 \times 10^{-5} \cdot \Delta TUBOD + 1.45 \times 10^{-6} \cdot DO_{DWSC_1}$$
$$+ 1.48 \times 10^{-13} \cdot (\Delta TUBOD)^2 \cdot DO_{DWSC_1} + 3.682 \times 10^{-3} \cdot DO_{DWSC_1} - 0.03994$$

Where:

ΔDO_{DWSC} = modeled change in DWSC DO due to the change in TUBOD load from the WQCF (mg/L).

$\Delta TUBOD$ = calculated change in total ultimate oxygen demand load from the WQCF (lb/d),

DO_{DWSC_1} = Deep water ship channel dissolved oxygen (DWSC DO) before the TUBOD load is changed in the WQCF effluent (mg/L).

The biologically oxidizable constituents in the WQCF effluent and the load of total ultimate oxygen demand for various phases of expansion are listed in **Table 29**. Also included in the table is the change in TUBOD load from the 6.0 MGD (ADWF) case providing one of the inputs to the regression model. The second input to the model is the original DWSC DO, and for the values listed in **Table 29**, the model is used to calculate

the change in DWSC DO from what the DO would have been in the DWSC under the conditions that existed when the WQCF discharged at an ADWF of 6.0 MGD (ADWF).

Table 29: Oxygen Demanding Substances and Loads from the WQCF for Increasing ADWF

Flowrate (MGD ADWF)	BOD₅ (mg/L)	Ammonia (mg/L as N)	TUBOD (lb/d)	ΔTUBOD[1] (lb/d)
6.0	20	22	7,537	---
8.11	20	2	4,002	-3,535
9.87 EDAW 2000	20	2	4,871	-2,666
9.87 Current	7	1.5	2,006	-5,531
17.5 Proposed	7	1.5	3,557	-3,981

(1) ΔTUBOD is the difference between loading at listed WQCF flowrate and TUBOD load for 6.0 MGD (ADWF) case for use in the regression model.

Results for DWSC DO: The regression model is used to estimate future DWSC DO concentrations for the proposed ADWF discharge rate in relation to DWSC DO that would have occurred when the WQCF permitted capacity was 6.0 MGD (ADWF). For example, if a certain set of conditions upstream in the San Joaquin River (e.g. temperature, BOD load, etc.), and flows and conditions in the delta (e.g. tides, export rates, etc.), combined with a 6.0 MGD (ADWF) WQCF discharge case result in a DWSC DO of 6.0 mg/L, then under the same conditions, but with the WQCF discharging under the current flowrate of 9.87 MGD (ADWF), the DWSC DO would be 6.21 mg/L. The change in DO in the DWSC caused by the City's discharge is also a function of the TUBOD load (i.e. a lower TUBOD load will result in higher DO levels). While the incremental change between the 9.87 MGD and the 17.5 MGD conditions shows a moderate increase in TUBOD and corresponding decrease in DO in the DWSC, the overall conclusion is that the TUBOD load to the river at 17.5 MGD is less than the load corresponding to the 6 MGD and 8.11 MGD conditions. Lower TUBOD loadings in the increased discharge will result in higher DWSC DO and thus no reasonable potential to cause or contribute to a negative impact on the dissolved oxygen impairment in the DWSC as compared to the TMDL baseline.

The complete suite of DWSC DO and the calculated concentration for the future projected WQCF flowrates are listed in **Table 30**. Additionally, the difference between DWSC DO for the proposed WQCF flowrate and the current permitted capacity of 9.87 MGD (ADWF) are included in the table. For the proposed 17.5 MGD (ADWF) discharge, the DWSC DO concentration in will be greater than when the WQCF capacity was 6.0 MGD (ADWF) and only 0.1 mg/L lower than levels at the current discharge conditions.

Modeling Approach Minimum Dissolved Oxygen: The Streeter-Phelps model is used to estimate the DO sag downstream of the WQCF discharge. Only the minimum DO downstream of the discharge is calculated for the present analysis in order to evaluate the impact of the project above the currently permitted discharge. The model is a function of the BOD_{ult} and DO concentrations, flowrates, temperature, and the BOD decay and reaeration rates. The R-1 and effluent information are available from the near-field analysis. The rate of BOD decay can be selected from previous modeling efforts. The reaeration can be estimated as a function of river depth and velocity. The detailed Streeter-Phelps analysis is presented in **Appendix A**.

Table 30: Modeled SDWSC DO (mg/L) and Change from Currently Permitted Levels

6.0 MGD (ADWF)	9.87 MGD (ADWF)	17.5 MGD (ADWF)	
DO in SDWSC	DO in SDWSC	DO in SDWSC	Difference from 9.87 MGD
4.00	4.22	4.11	-0.11
5.00	5.22	5.11	-0.11
6.00	6.21	6.11	-0.10
7.00	7.21	7.11	-0.10
8.00	8.20	8.10	-0.10
9.00	9.20	9.10	-0.10

Monthly values used to perform the Streeter-Phelps analysis are listed in **Table 31**. The near field analyses R-1 concentrations of 5.26 mg/L BOD_5 and 0.13 mg/L as N ammonia are utilized in the DO analyses. Note that considering the seasonality of ammonia does not affect the results appreciably and therefore the higher summer value is used as a conservative number for the minimum DO analysis. During the summer, the San Joaquin River is supersaturated with oxygen during the day, presumably due to algal photosynthesis.

Table 31: Monthly Input Values for Parameters in the Streeter-Phelps Dissolved Oxygen Model

Month	Temp. (ºF)	Flowrate (cfs)	Depth (m)	Velocity (m/s)	DOsat (mg/L)	DO_{R-1} (mg/L)
Jan	50	2,662	2.9	0.26	11.3	9.3
Feb	53	1,897	2.4	0.22	11.0	8.8
Mar	58	2,137	2.6	0.24	10.3	8.4
Apr	63	2,666	2.9	0.26	9.7	9.1
May	67	2,684	2.9	0.26	9.3	9.1
Jun	72	1,394	2.0	0.20	8.7	10.1
Jul	76	1,220	1.8	0.19	8.4	9.1
Aug	76	1,118	1.7	0.18	8.4	7.2
Sep	71	1,182	1.8	0.19	8.9	8.0
Oct	65	2,003	2.5	0.23	9.5	7.3
Nov	56	2,091	2.5	0.23	10.5	7.8
Dec	49	2,064	2.5	0.23	11.6	8.7

The resulting total ultimate oxygen demand concentration for R-1 is 13.7 mg/L. As noted above, the future effluent total ultimate oxygen demand concentration is 24 mg/L which represents a 7 mg/L BOD_5 and 1.5 mg/L as N ammonia. The initial concentrations of total ultimate oxygen demand where WQCF effluent is well-mixed with the San Joaquin River for each case considered in the project are listed in **Table 32**.

Table 32: Initial Total Ultimate Oxygen Demand, L_i, for Streeter-Phelps Analysis

Case (MGD ADWF)	Initial TUBOD (mg/L)
R-1	13.7
9.87	13.9
17.5	14.0

Results Dissolved Oxygen: The results generated from the Streeter-Phelps model can only be utilized to evaluate the relative impact of increasing the WQCF discharge rate. The model does not account for tidal cycles, inputs to the river downstream of the WQCF, sediment oxygen demand, daylight oxygen generation, etc. and should not be used to estimate future absolute DO concentrations. The model does account for the consumption of oxygen as organic matter and ammonia are oxidized; and replenishment of oxygen from the atmosphere. The Streeter-Phelps model should only used to evaluate the incremental impact on DO concentrations in the San Joaquin River as the WQCF discharge rate is increased.

Monthly results of the Streeter-Phelps analysis are listed in Error! Reference source not found.. The location of the critical oxygen condition will vary from immediately at the point of discharge to several days float time downstream of the discharge. Because the analysis does not included any additional inputs to the river downstream of the discharge, as the critical position moves further downstream the value of the absolute minimum DO concentration will be less precise. However, the incremental change in DO with implementation of the project can be well estimated by the model.

Table 33: Streeter-Phelps Analysis Results for Proposed 17.5 MGD (ADWF) WQCF Flowrate

Month	Time Θ_H^* (d)[1]	Distance (miles)	9.87 MGD DO min. (mg/L)	17.5 MGD DO min. (mg/L)	17.5 MGD Δ (mg/L)[2]
Jan	2.9	40.7	8.95	8.93	-0.02
Feb	0.5	5.9	8.78	8.76	-0.02
Mar	2.4	30.8	8.09	8.07	-0.02
Apr	4.5	62.5	7.44	7.42	-0.02
May	4.6	63.8	7.04	7.02	-0.02
Jun	4.0	43.0	7.22	7.21	-0.01
Jul	3.3	33.5	6.90	6.88	-0.02
Aug	1.8	17.9	6.71	6.70	-0.01
Sep	2.3	23.3	7.30	7.28	-0.02
Oct	1.7	21.5	7.09	7.08	-0.01
Nov	0.0	0.0	7.80	7.79	-0.01
Dec	0.0	0.0	8.68	8.66	-0.02

(1) Critical flow time corresponding to the 9.87 MGD case. The float time for the 17.5 MGD case is nearly identical.
(2) Difference between DO_{min} for case and DO_{min} for 9.87 MGD case.

The calculated, minimum DO concentration for no discharge, 9.87 MGD (ADWF) and 17.5 MGD (ADWF) are plotted in **Figure 24**. The incremental change in minimum river DO concentrations is limited to less than 0.1 mg/L between the currently permitted discharge rate of 9.87 MGD (ADWF) and the proposed discharge rate of 17.5 MGD (ADWF). It would be unlikely to be able to measure the difference in San Joaquin River DO as the WQCF effluent rate is increased from 9.87 MGD (ADWF) to 17.5 MGD (ADWF).
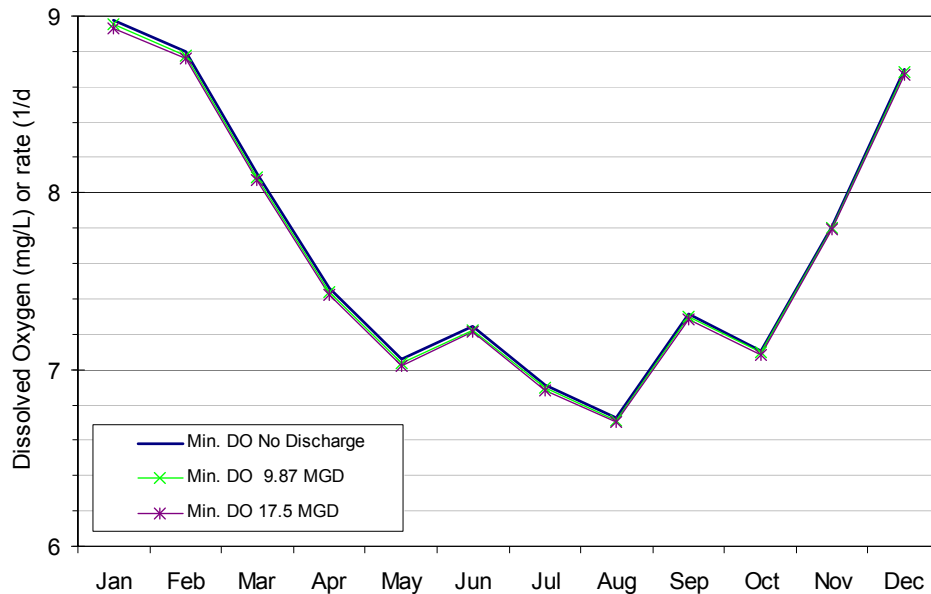
Figure 24: Monthly Minimum Dissolved Oxygen from Streeter-Phelps Analysis of San Joaquin River and WQCF Discharge

Comparison to Water Quality Objectives: The DO objective in the San Joaquin River between Turner Cut and Stockton during September through November is 6 mg/L; otherwise, the objective is 5 mg/L for the river within the boundaries of the Delta. For the DWSC DO the proposed project does not affect DO concentrations by more than 0.11 mg/L. The minimum DO downstream from the WQCF discharge is not affected by more than 0.02 mg/L.

Evaluation: Because the load of biologically oxidizable material carried by the San Joaquin River at R-1 far overshadows the load from the WQCF at the proposed discharge rate, the incremental change in DO due to the project is minor both in the river downstream of the WQCF or in the DWSC. As part of the phased approach to the adopted TMDL for DO in the DWSC (CVRWQCB, 2005), studies are currently being performed to allow calculation of waste load and load allocations to achieve the DO targets in the DWSC. Load from the WQCF has little effect on the DWSC DO concentrations and WLAs scheduled for the December 2009 revisitation of the TMDL should not be required for the WQCF discharge. Because of the small impact on DO, the WQCF discharge should fall into the margin of safety or the reserve portion of the TMDL allocations. The reasonable potential for the DO objectives to be exceeded is not significantly affected by the project.

Manteca WQCF Effluent Contribution to Far-Field Delta Locations

The percent contribution (by volume) of WQCF effluent is calculated for several points of interest within the Sacramento-San Joaquin River Delta for both critical and dry/below normal water years as a measure of the potential effect that increasing WQCF discharge capacity might have in the far-field. Furthermore, the percent WQCF effluent contributions are used in conjunction with historic Delta water quality data and historic Manteca effluent data to estimate the incremental change in Delta water quality with increases in WQCF discharge.

Modeling Approach: A two-dimensional, depth averaged, finite element model of the Delta extending from Martinez at the downstream end, up the Sacramento River to the American River confluence, and up the San Joaquin River to Vernalis (RMA 2006) is used to perform far-field dilution analysis simulations. The boundary conditions of the model include 15-minute tidal inputs at Martinez; historical daily inflows for the Sacramento River, San Joaquin River, Cosumnes River, Mokelumne River, Yolo Bypass, and other inflows (e.g. Calaveras River, French Camp Slough, etc.); historical exports at Delta Mendota Canal (DMC), Contra Costa at Old River, Contra Costa at Rock Slough, the North Bay Aqueduct, Clifton Court used by the State Water Project (SWP); and inflows and withdrawals by Delta Islands. Additionally, historical operations of the operable gates and temporary barriers are included in the far-field delta model. The model domain is presented in **Figure 25**, and detailed in "Near and Far Field Dilution Analysis of the Manteca Wastewater Discharge" (RMA 2006).

Model simulations evaluating the WQCF operating under the timed discharge schedule with daily average discharge rates of current 9.87 and proposed 17.5 MGD (ADWF) are used to determine the incremental impacts of the project within the Delta.[3] Model results are tracked at six locations within the Delta as indicated in **Figure 26**. Simulations for nominal San Joaquin River flowrates of 600 cfs and 1,250 cfs were performed to evaluate critical and dry/below normal water years, respectively.

Results: The minimum and maximum calculated WQCF effluent contributions for six selected locations within the Delta are listed in **Tables 34** and **35** corresponding to critical and dry/below normal water years, respectively. In general, the further away from the WQCF the far-field site is located, the lower the percent contribution of WQCF effluent, and as WQCF discharge increases, so does its percent contribution at far-field locations. The calculated WQCF percent contribution exceedance plots are presented for six selected Delta locations in **Figures 27** through **32**. For example, from **Figure 27**, less than 0.5% of the water at the State Water Project Clifton Court intake will be of WQCF origin for 80% of a critical water year; and for more than 95% of a dry/below normal water year at a WQCF discharge rate of 17.5 MGD (ADWF). Lower WQCF discharge results in lower percent contributions of WQCF effluent at far-field locations.

Comparison to Water Quality Objectives: There are no established objectives for the percent contribution a wastewater treatment facility's effluent can make within waters of the Delta.

Evaluation: With the sole exception of the Stockton Turning Basin, even under critical water year conditions and a WQCF discharge rate of 17.5 MGD (ADWF), the maximum percentage of water of Manteca WQCF effluent origin is less than 2% of the water at selected Delta locations. Under critical water year conditions, the maximum contribution at the Stockton Turning Basin is still a low 3.7%.

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[3] It should be noted that the referenced 2006 RMA study was conducted in conjunction with the Draft Environmental Impact Report (EIR) for the City of Manteca WQCF and Collection System Master Plans Update Project, prepared by EDAW in July 2007 (EDAW, 2007). This Draft EIR and the referenced 2006 RMA study associated with it consider both Phase IV (17.5 MGD (ADWF)) and Phase V (27.0 MGD (ADWF)) elements of the proposed WQCF expansion. For the purposes of the current Antidegradation Analysis, references to findings from the RMA 2006 study are only regarding those findings related to the Phase IV (17.5 MGD(ADWF)) WQCF expansion.
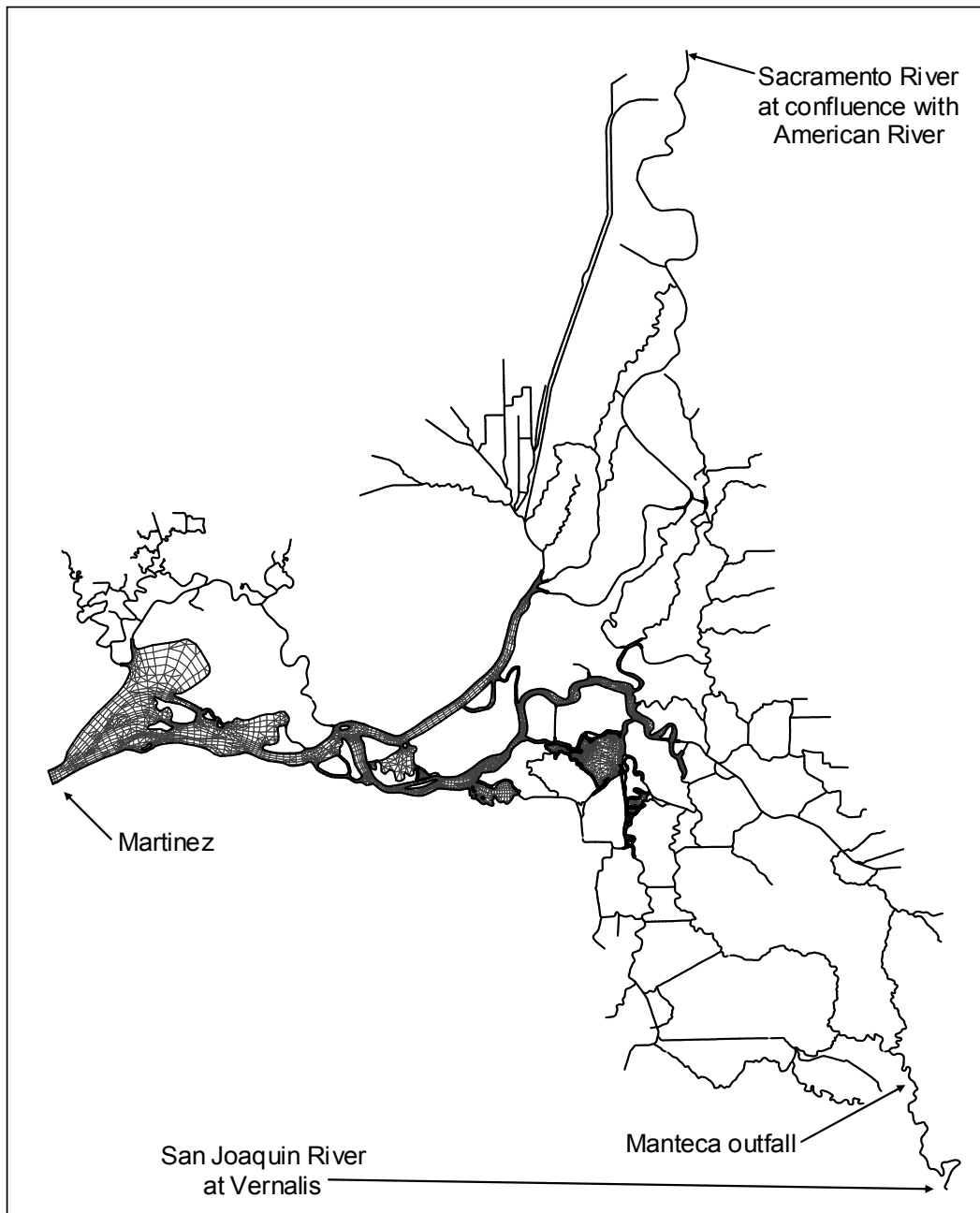
Figure 25: Finite Element Mesh of Simulated Waterways for Far-Field Simulations (RMA 2006)
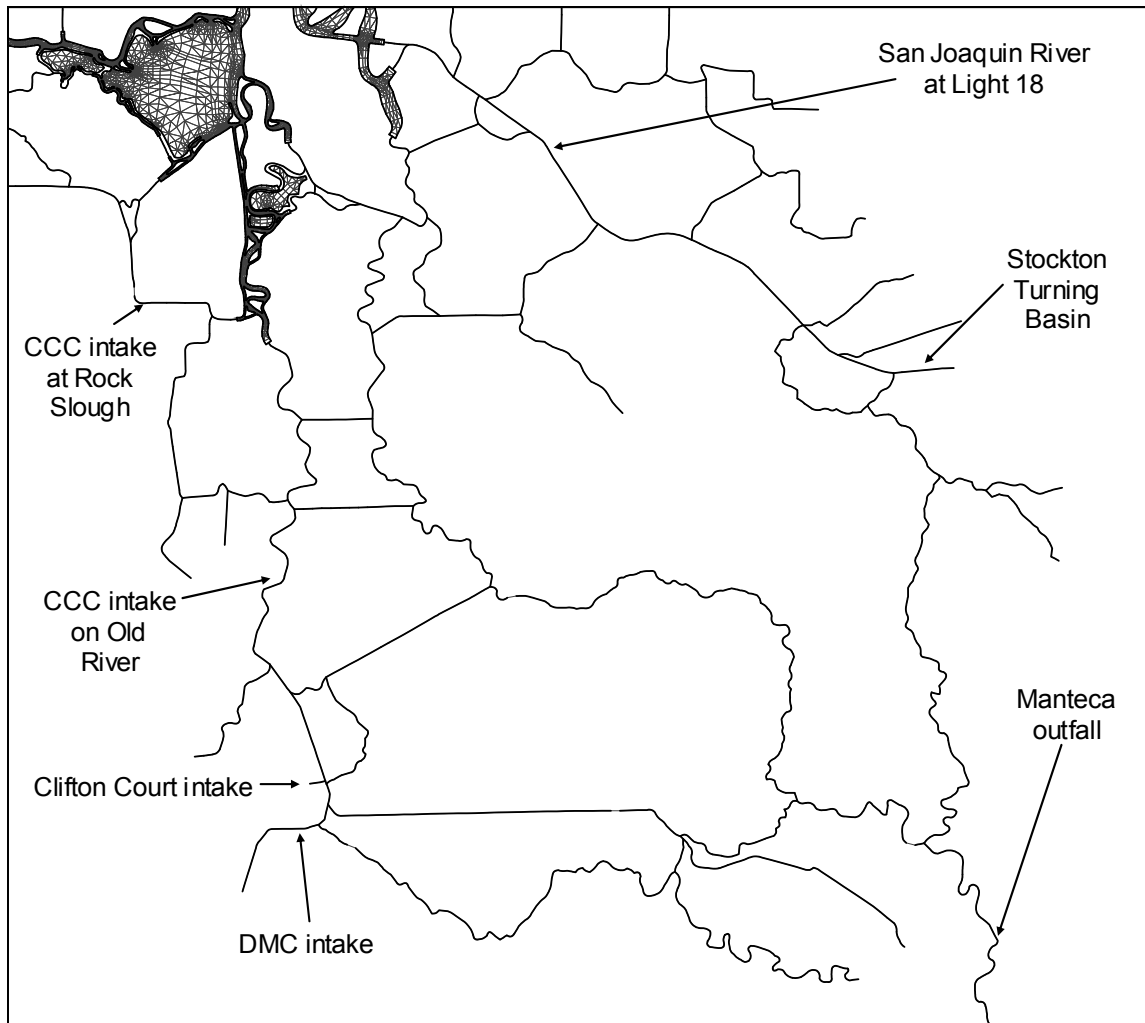
Figure 26: Select Locations within the Delta Considered in the Far Field Analysis (RMA 2006)

Table 34: Summary of Minimum and Maximum Effluent Concentrations for Critical Water Year Flowrates of 600 cfs at Vernalis (RMA 2006)

Location	Minimum Effluent Contribution		Maximum Effluent Contribution	
	9.87 MGD (ADWF)	17.5 MGD (ADWF)	9.87 MGD (ADWF)	17.5 MGD (ADWF)
SWP Clifton Court intake	<0.1%	<0.1%	1.0%	1.7%
CVP DMC intake	<0.1%	0.1%	1.1%	1.9%
CCWD intake at Rock Slough	<0.1%	<0.1%	0.2%	0.3%
CCWD intake at Old River	<0.1%	<0.1%	0.3%	0.5%
San Joaquin River at Light 18	<0.1%	<0.1%	0.9%	1.6%
Stockton Turning Basin	0.2%	0.3%	2.1%	3.7%

Table 35: Summary of Minimum and Maximum Effluent Concentrations for Dry/Below Normal Water Year Flowrates of 1,250 cfs at Vernalis (RMA 2006)

Location	Minimum Effluent Contribution		Maximum Effluent Contribution	
	9.87 MGD (ADWF)	17.5 MGD (ADWF)	9.87 MGD (ADWF)	17.5 MGD (ADWF)
SWP Clifton Court intake	<0.1%	<0.1%	0.6%	1.0%
CVP DMC intake	0.1%	0.2%	0.6%	1.0%
CCWD intake at Rock Slough	<0.1%	<0.1%	0.1%	0.3%
CCWD intake at Old River	<0.1%	<0.1%	0.2%	0.4%
San Joaquin River at Light 18	<0.1%	0.1%	0.5%	1.0%
Stockton Turning Basin	0.5%	0.8%	1.2%	2.1%
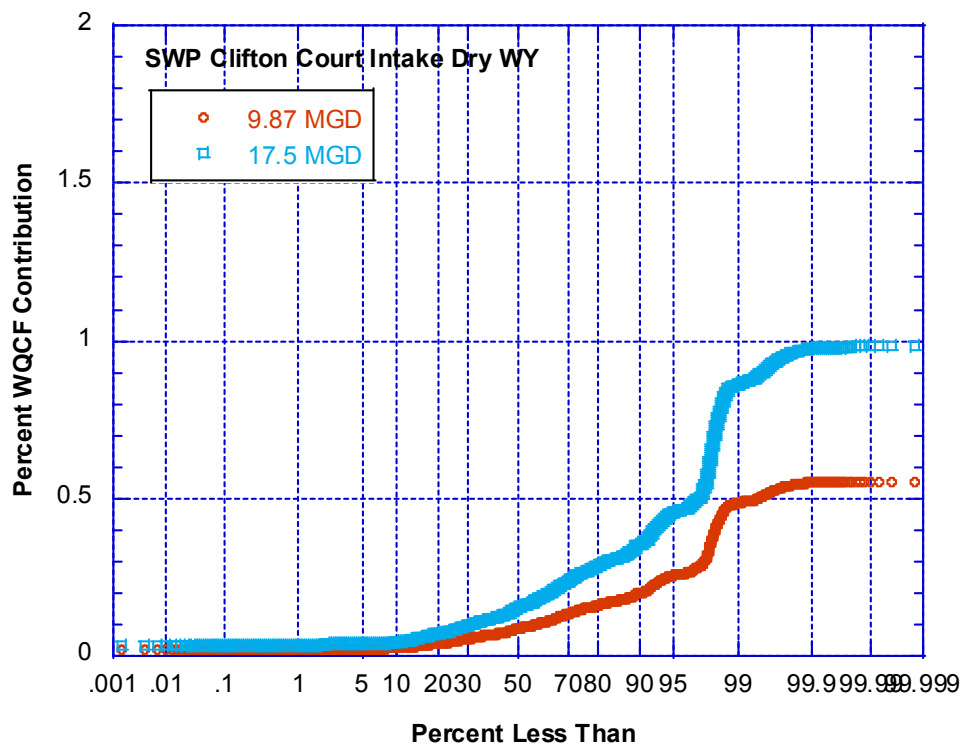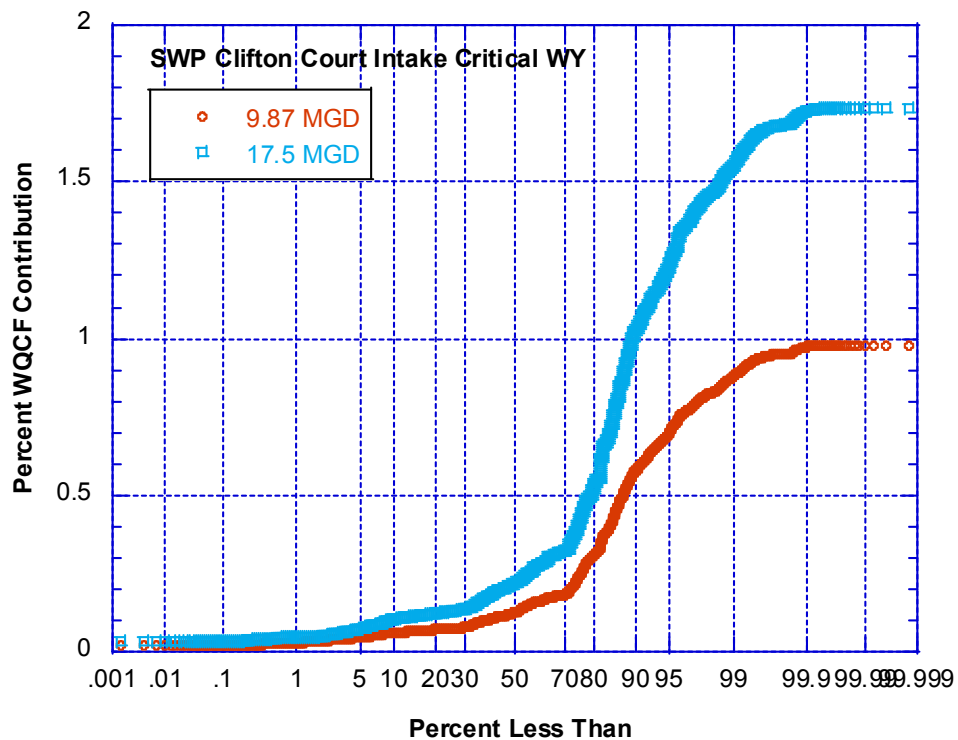
Figure 27: Frequency Plots of WQCF Contribution at the State Water Project (SWP) Intake at Clifton Court for Critical and Dry/Below Normal Water Years
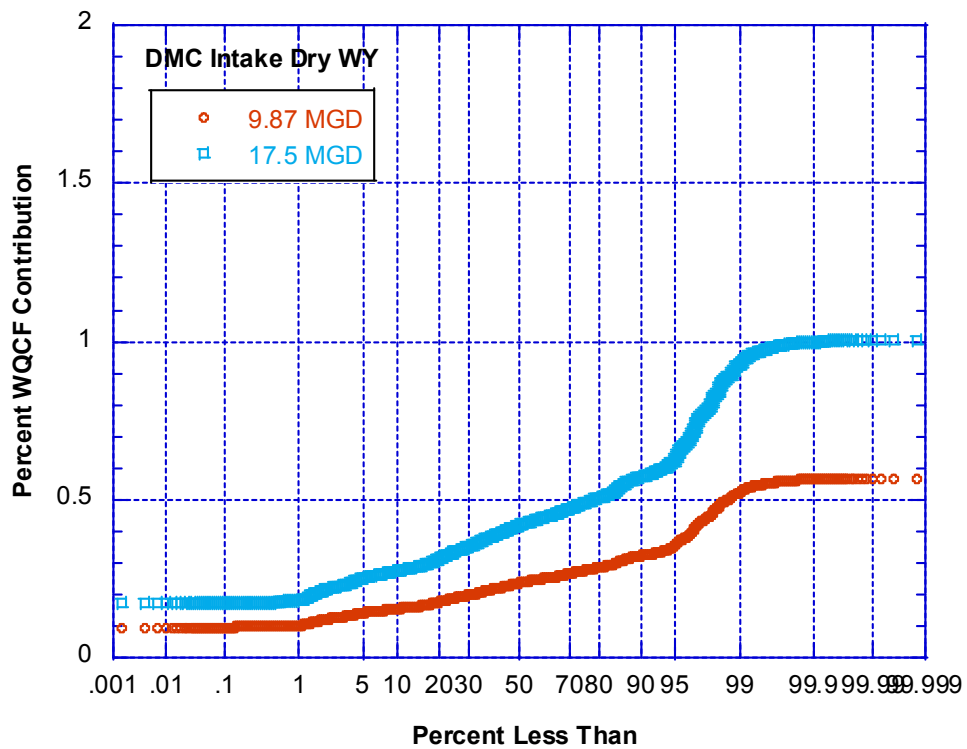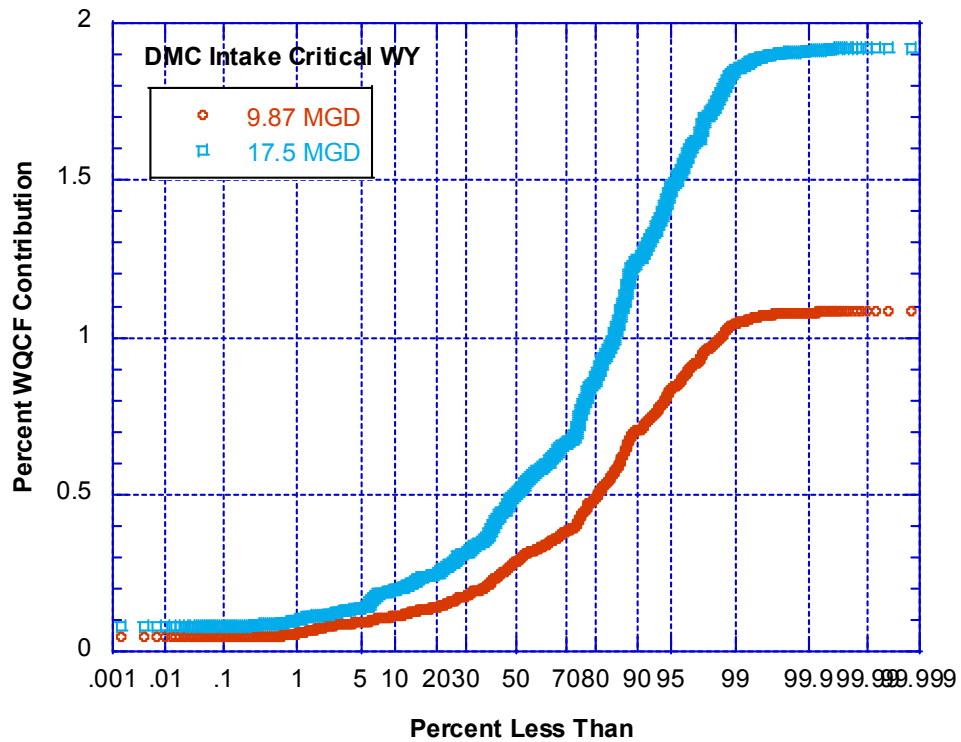
Figure 28: Frequency Plots of WQCF Contribution at the Central Valley Project (CVP) Delta Mendota Canal Intake for Critical and Dry/Below Normal Water Years
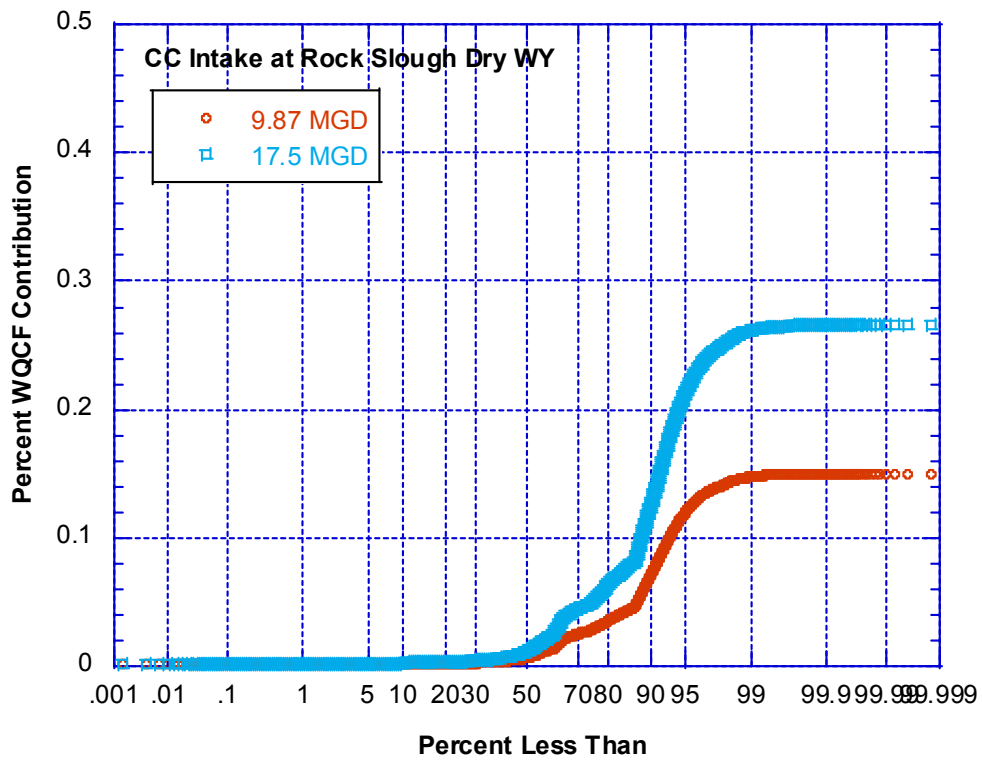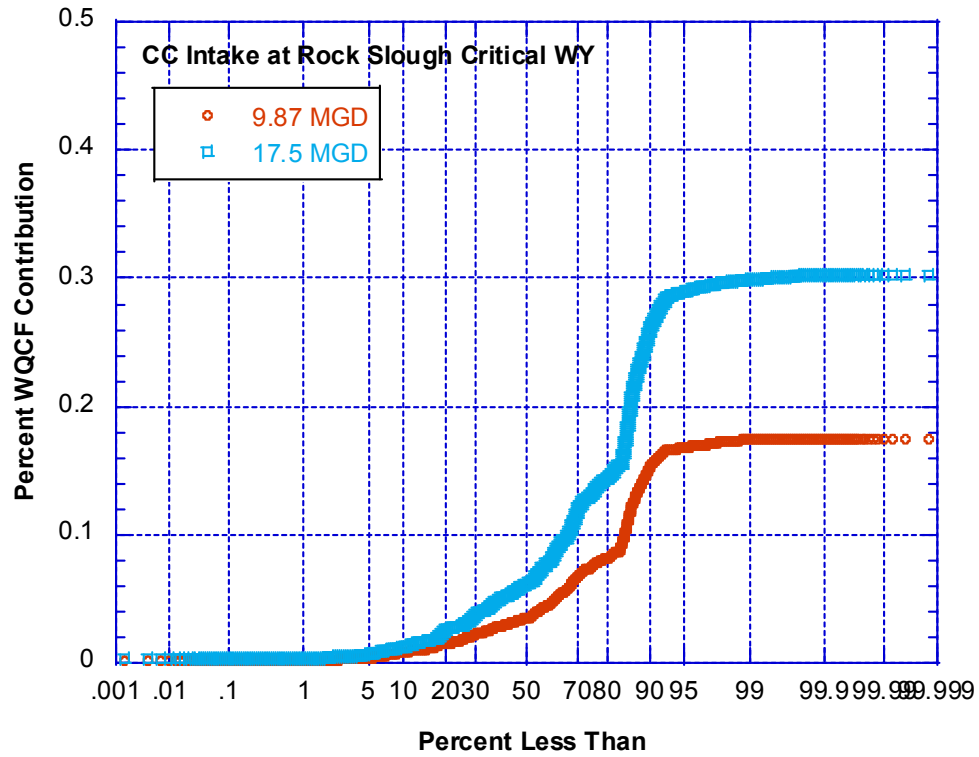
Figure 29: Frequency Plots of WQCF Contribution at the Contra Costa Water District Intake at Rock Slough for Critical and Dry/Below Normal Water Years
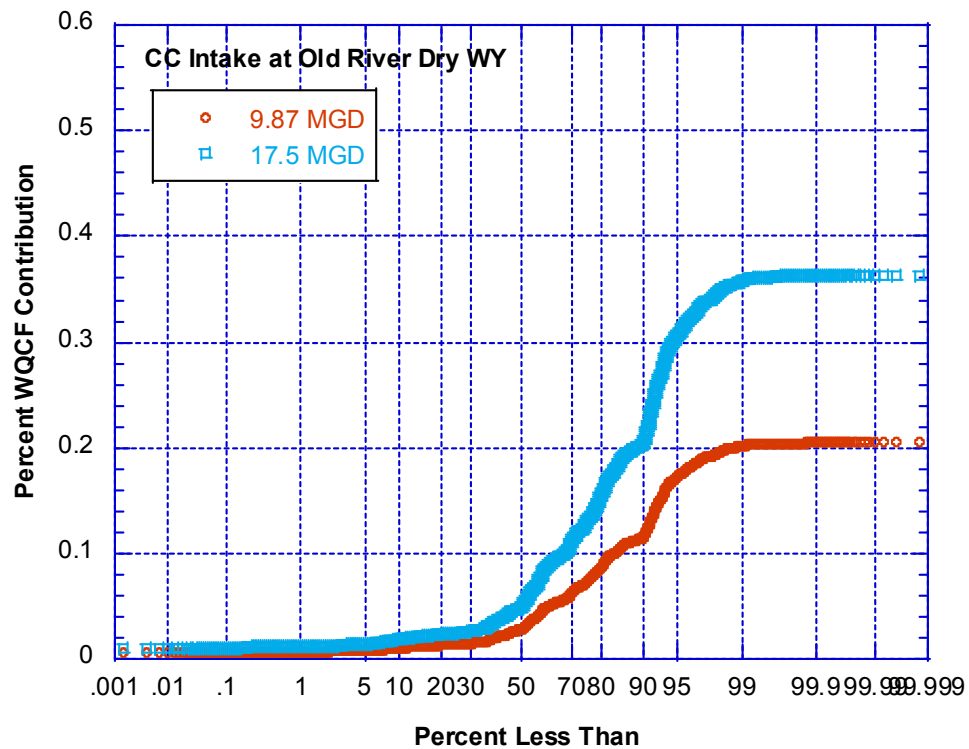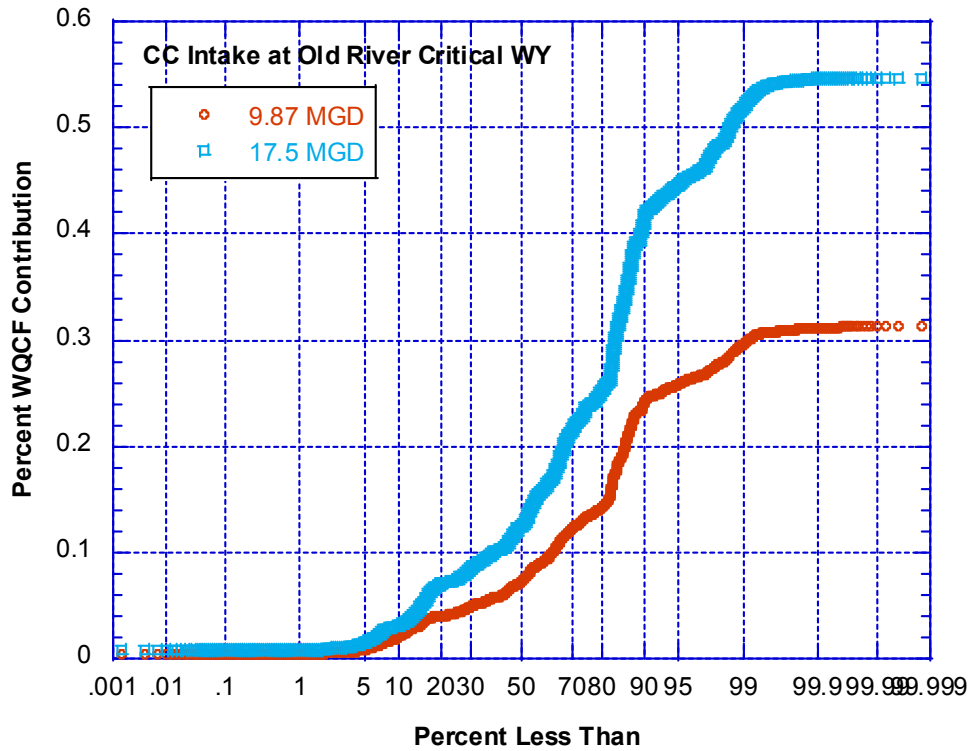
Figure 30: Frequency Plots of WQCF Contribution at the Contra Costa Water District Intake at Old River for Critical and Dry/Below Normal Water Years
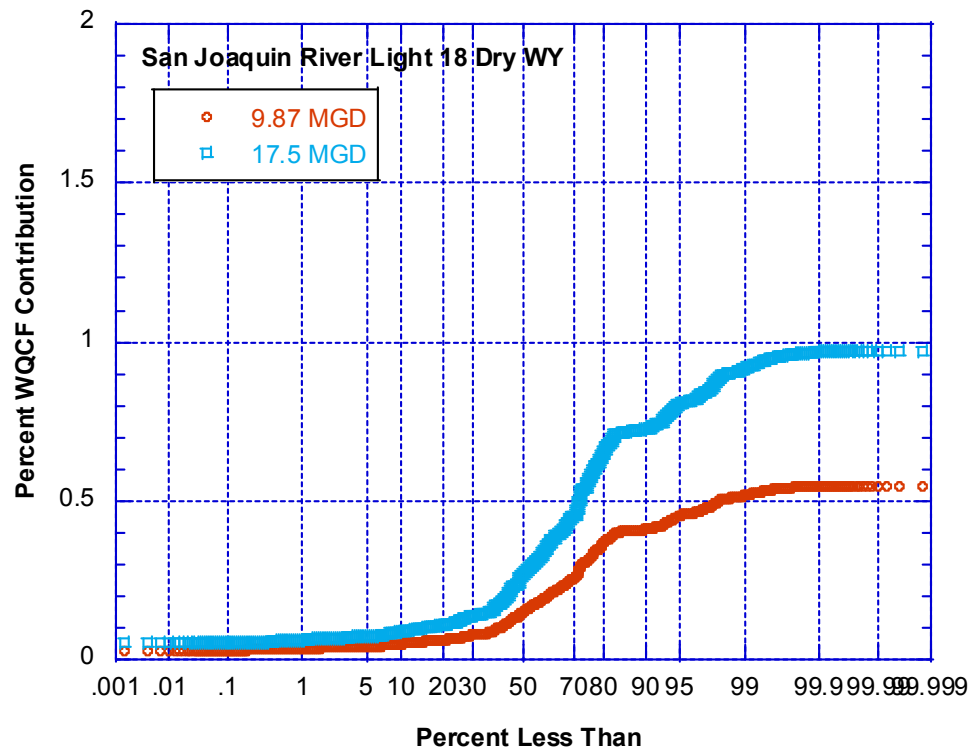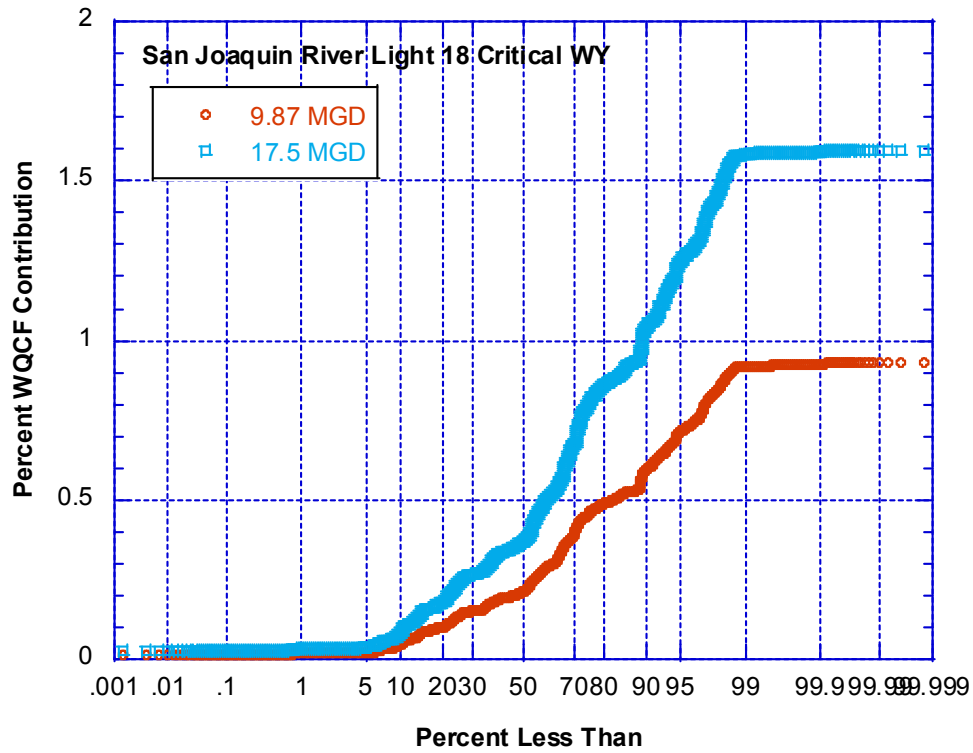
Figure 31: Frequency Plots of WQCF Contribution in the San Joaquin River at Navigation Light 18 for Critical and Dry/Below Normal Water Years
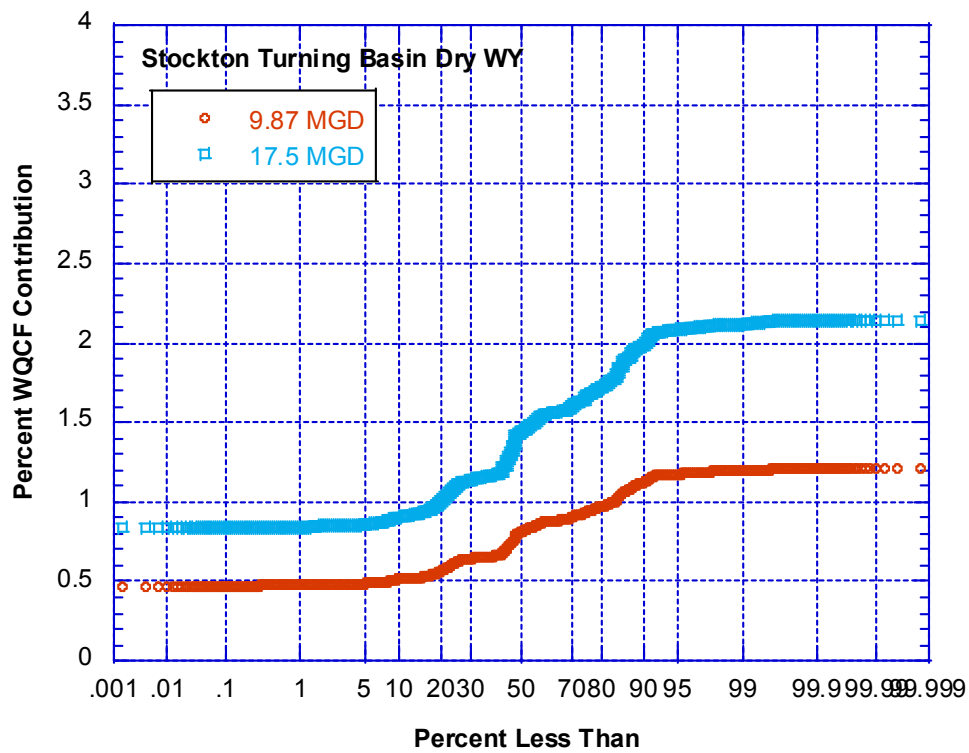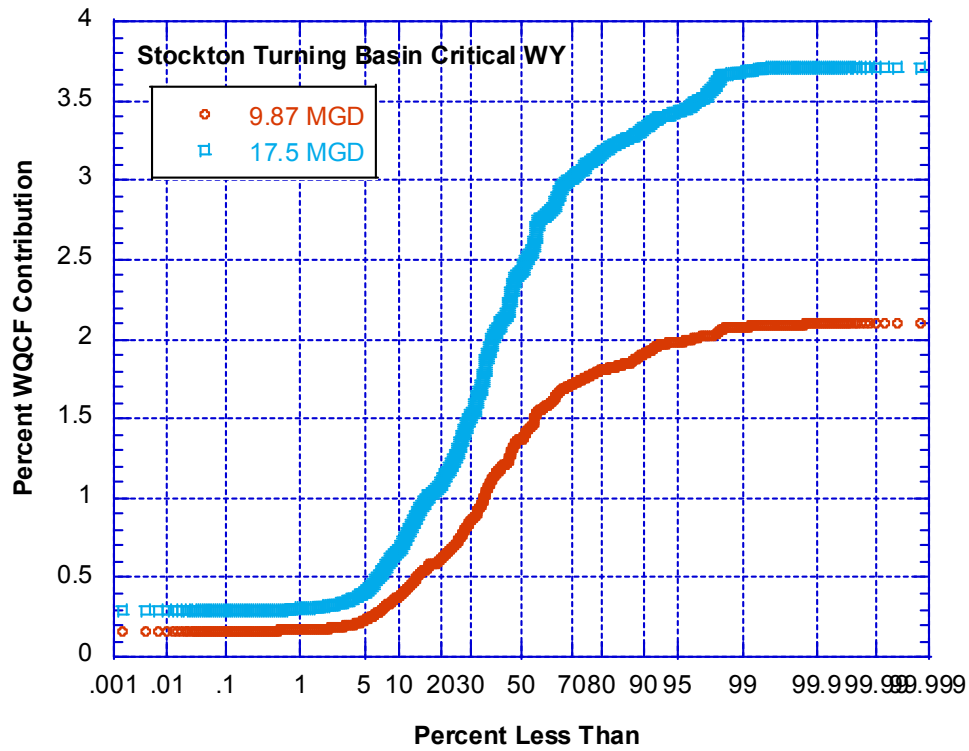
Figure 32: Frequency Plots of WQCF Contribution in the San Joaquin River at the Stockton Ship Channel Turning Basin for Critical and Dry/Below Normal Water Years

Far-Field Water Quality Parameters

Combining available surface water quality data with the percent contribution of WQCF effluent in the Sacramento-San Joaquin River Delta allows an estimation of the incremental change in water quality in response to the proposed project. The analysis is clearly appropriate for conservative parameters such as EC. However, due to the lack of a well-defined model for DOC or nitrate transformations, all potential sources and sinks of these two parameters are ignored, and they are treated as conservative.

Modeling Approach: The percent contribution results from the Delta hydrologic model (RMA 2006) allow the use of a mass balance model to estimate incremental changes in water quality at six far-field Delta locations. Calculation of far-field water quality estimates requires the following multi-step process:

1. Use the percent contributions of WQCF effluent for flowrates of 9.87 and 17.5 MGD (ADWF) at each site within the Delta to estimate the percent contribution of WQCF effluent at historic flowrates corresponding to the modeled water years.

2. Determine the WQCF effluent quality corresponding to the modeled water years.

3. Determine the WQCF effluent quality corresponding to the proposed project scenario.

4. Determine the observed water quality in the Delta corresponding to the modeled water years.

5. Use the historic WQCF effluent quality and percent contribution to estimate the Delta water quality *sans* WQCF discharge.

6. Calculate the projected water quality in the Delta for the proposed project scenario using projected effluent quality and percent contribution in conjunction with the Delta water quality *sans* WQCF discharge.

The WQCF percent effluent contribution to the water column within the Delta (RMA 2006) is used to project the WQCF contribution for the historic WQCF flowrates corresponding to the modeled water years. The modeled water years are 1991/1992 and 2001/2002, the most recent critical and the most recent dry/below normal water years, respectively, for which river data are available. During the critical water year (1991/1992) the WQCF had a flowrate of 2.1 MGD (ADWF), and during the dry/below normal water year (2001/2002) the flowrate was 3.5 MGD (ADWF). Because the percent contribution of WQCF effluent to the selected locations is low, the response in relation to changes in the ADWF is approximately linear. The process for the critical water year projection at the DWSC is presented in **Figure 33**. By repeating the process for the other locations in the Delta, the percent contributions of WQCF effluent at the other selected locations can be calculated for both the critical and dry/below normal water years (1991/1992 and 2001/2002, respectively). The percent contributions of WQCF effluent at the selected locations in the Delta for critical and dry/below normal water years are listed in **Tables 36** and **37**, respectively.
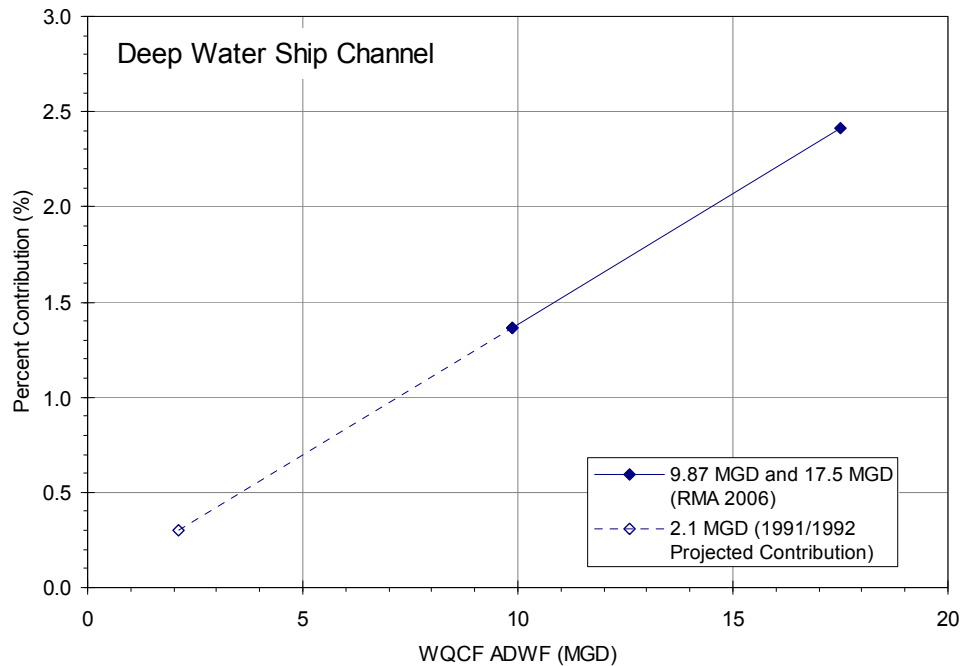
Figure 33: Projection of Percent Contributions Back to Conditions of Modeled Critical Water Year (1991/1992)

Table 36: Median Percent Contribution of WQCF Effluent at Select Locations within the Delta for Critical Water Years (adapted from RMA 2006)

Location	Percent Contribution for WQCF ADWF (%)		
	2.1[(1)] MGD	9.87 MGD	17.5 MGD
SWP Clifton Court Intake	0.0307	0.1252	0.2209
CVP DMC Intake	0.0703	0.2878	0.5034
CCWD Intake at Rock Slough	0.0083	0.0352	0.0620
CCWD Intake at Old River	0.0181	0.0725	0.1254
San Joaquin River at Light 18	0.0523	0.2132	0.3717
Stockton Turning Basin	0.3003	1.3676	2.4157

(1) For the modeled critical water year (1991/1992) the WQCF ADWF was 2.1 MGD (ADWF).

Table 37: Median Percent Contribution of WQCF Effluent at Select Locations within the Delta for Dry/Below Normal Water Years

	Percent Contribution for WQCF ADWF (%)		
Location	3.5[1] MGD	9.87 MGD	17.5 MGD
SWP Clifton Court Intake	0.0311	0.0867	0.1534
CVP DMC Intake	0.0839	0.2365	0.4193
CCWD Intake at Rock Slough	0.0025	0.0068	0.0119
CCWD Intake at Old River	0.0102	0.0281	0.0495
San Joaquin River at Light 18	0.0540	0.1514	0.2681
Stockton Turning Basin	0.2891	0.8152	1.4454

(1) For the modeled dry/below normal water year (2001/2002) the WQCF ADWF was 3.5 MGD (ADWF).

Historic WQCF effluent quality is listed in **Table 38**. Only total dissolved solids (TDS) data are available for the 1991/1992 historic WQCF effluent quality. To estimate the EC values, the historic TDS values are scaled by the EC/TDS ratio measured during the WQCF's 13267 monitoring. The 13267 data are used to estimate the dry/below normal water year value. The future EC is derived from the Master Plan Update (Nolte, 2007).

Table 38: WQCF Typical Effluent Quality for Historic and Future Conditions

Parameter	Critical WY 1991/1992	Dry WY 2001/2002	Proposed Project
ADWF (MGD)	2.1	3.5	17.5
EC (µmhos/cm)	1,203[1]	1,143[2]	825[3]
DOC (mg/L)[4]	9.0	9.0	9.0
Nitrate (mg/L)	0.8	4.6	7.0

(1) TDS value of 642 mg/L scaled by EC/TDS ratio of (1,143/610).
(2) Mean EC value from 13267 monitoring.
(3) City of Manteca WQCF Master Plan Update January 2007: Table 2-4 ~ Schedule D (Nolte, 2007).
(4) Data only available from August 2005 to April 2006.

Historic ambient water quality conditions at six Delta locations were calculated using data available from several monitoring programs (see **Table 7** and **Table 8**). Representative water quality estimates for EC, DOC, and nitrate for each location and modeled water year are presented in the following Results subsection in **Tables 39** through **44**.

Using the representative water quality at each location in the Delta (C_{obs}), the WQCF effluent quality (C_{eff}) for the modeled water years, and the estimated WQCF percent effluent contribution (f = percentage/100%), a mass balance equation can be used to estimate the water quality in the Delta without a discharge at Manteca ($C_{sans\ WQCF}$).

$$C_{sans\ WQCF} = \frac{C_{obs} - f \cdot C_{eff}}{(1 - f)}$$

Using the estimate of water quality within the Delta without a WQCF discharge ($C_{sans\,WQCF}$), the model results for the contribution of WQCF effluent from project scenarios (f = percentage/100%) may be used in conjunction with projected future WQCF effluent quality (C_{eff}) to estimate the future Delta water quality (C_{future}). The approach is most applicable to EC, as it is a conservative parameter. The approach is also used for nitrate and DOC, both of which undergo reactions and transformations as they travel downstream and through the Delta, therefore the results presented here overestimate the WQCF contribution of these constituents to the Delta.

$$C_{future} = C_{sans\,WQCF} + f \cdot (C_{eff} - C_{sans\,WQCF})$$

Results for the three constituent are tabulated below.

Results: The results from the far-field analysis are presented in **Tables 39** to **44**. Two tables are presented for each constituent representing the results for the critical and dry/below normal water year conditions. The observed water quality for each location is listed under the 2.1 MGD (ADWF) scenario for critical water year conditions and 3.5 MGD (ADWF) for dry/below normal water year conditions. Each table includes a project build-out percent change in concentration, calculated by comparing the calculated concentrations at a location corresponding to the WQCF operating at ADWFs of 9.87 MGD and 17.5 MGD.

EC results are presented in **Tables 39** and **40**, corresponding to critical and dry/ below normal water years, respectively. Monitoring data for EC are not available for the San Joaquin River at Navigation Light 18 and the Stockton Ship Channel Turning Basin for critical water years and the Delta Mendota Canal intake and Contra Costa Water District intake at Old River for dry/below normal water years. For both water year types, the calculated change in EC at the selected sites is typically less than 1 µmho/cm and no greater than 2 µmho/cm when the WQCF ADWF is increased from 9.87 to 17.5MGD.

Table 39: Median Electrical Conductivity (EC) at Select Locations within the Delta for Project Scenarios under Critical Water Year Conditions

Location	EC (µmhos/cm) for WQCF ADWF (MGD)				Δ[3] (µmhos/cm)
	0.0[1]	2.1[2]	9.87	17.5	
SWP Clifton Court Intake	546	547	547	547	< 1
CVP DMC Intake	593	593	594	594	< 1
CCWD Intake at Rock Slough	599	599	599	599	< 1
CCWD Intake at Old River	578	578	578	578	< 1
San Joaquin River at Light 18	No Data				
Stockton Turning Basin	No Data				

(1) Estimated water quality at the selected location without WQCF effluent.

(2) The WQCF ADWF during the modeled critical water year was 2.1 MGD. Values listed represent the median observed at the location

(3) Incremental change between current permitted condition (9.87 MGD (ADWF)) and proposed project (17.5 MGD (ADWF)).

Table 40: Median Electrical Conductivity (EC) at Select Locations within the Delta for Project Scenarios under Dry/Below Normal Water Year Conditions

Location	EC (µmhos/cm) for WQCF ADWF (MGD)				Δ[3] (µmhos/cm)
	0.0[1]	2.1[2]	9.87	17.5	
SWP Clifton Court Intake	428	429	429	429	< 1
CVP DMC Intake			No Data		
CCWD Intake at Rock Slough	525	525	525	525	< 1
CCWD Intake at Old River			No Data		
San Joaquin River at Light 18	336	337	337	337	< 1
Stockton Turning Basin	652	654	654	655	1

(1) Estimated water quality at the selected location without WQCF effluent.

(2) The WQCF ADWF during the modeled critical water year was 3.5 MGD. Values listed represent the median observed at the location.

(3) Incremental change between current permitted condition (9.87 MGD (ADWF)) and proposed project (17.5 MGD (ADWF)).

DOC results are presented in **Tables 41** and **42**, corresponding to critical and dry/ below normal water years, respectively. Monitoring data for DOC are not available for the San Joaquin River at Navigation Light 18 and the Stockton Ship Channel Turning Basin for critical water years and the Delta Mendota Canal intake and Contra Costa Water District intake at Old River for the dry/below normal water year. For both water year types, the calculated change in DOC at the selected sites is generally less than 0.02 mg/L when the WQCF ADWF is increased from 9.87 to 27 MGD (ADWF), with the exception of the Stockton Ship Channel Turning Basin where the change is estimated to be 0.08 mg/L during a dry/below normal water year.

Table 41: Median Dissolved Organic Carbon (DOC) at Select Locations within the Delta for Project Scenarios under Critical Water Year Conditions

Location	DOC (mg/L) for WQCF ADWF (MGD)				Δ[3] (mg/L)
	0.0[1]	2.1[2]	9.87	17.5	
SWP Clifton Court Intake	3.90	3.90	3.90	3.91	0.01
CVP DMC Intake	3.90	3.90	3.91	3.92	0.01
CCWD Intake at Rock Slough	3.50	3.50	3.50	3.50	< 0.01
CCWD Intake at Old River	3.50	3.50	3.50	3.51	0.01
San Joaquin River at Light 18			No Data		
Stockton Turning Basin			No Data		

(1) Estimated water quality at the selected location without WQCF effluent.
(2) The WQCF ADWF during the modeled critical water year was 2.1 MGD. Values listed represent the median observed at the location.
(3) Incremental change between current permitted condition (9.87 MGD (ADWF)) and proposed project (17.5 MGD (ADWF)).

Table 42: Median Dissolved Organic Carbon (DOC) at Select Locations within the Delta for Project Scenarios under Dry/Below Normal Water Year Conditions

Location	DOC (mg/L) for WQCF ADWF (MGD)				$\Delta^{(3)}$ (mg/L)
	0.0[1]	2.1[2]	9.87	17.5	
SWP Clifton Court Intake	2.90	2.90	2.90	2.91	0.01
CVP DMC Intake	No Data				
CCWD Intake at Rock Slough	3.10	3.10	3.10	3.10	< 0.01
CCWD Intake at Old River	No Data				
San Joaquin River at Light 18	2.70	2.70	2.71	2.71	< 0.01
Stockton Turning Basin	3.38	3.40	3.43	3.47	0.04

(1) Estimated water quality at the selected location without WQCF effluent.
(2) The WQCF ADWF during the modeled critical water year was 3.5 MGD. Values listed represent the median observed at the location.
(3) Incremental change between current permitted condition (9.87 MGD (ADWF)) and proposed project (17.5 MGD (ADWF)).

Nitrate results are listed in **Tables 43**, and **44**, corresponding to critical and dry/ below normal water years, respectively. Monitoring data for nitrate are not available for the San Joaquin River at Navigation Light 18 and the Stockton Ship Channel Turning Basin for critical water years and the Delta Mendota Canal intake and Contra Costa Water District intake at Old River for the dry/below normal water year. For both water year types, the calculated change in nitrate at the selected sites is in general less than 0.02 mg/L as N when the WQCF ADWF is increased from 9.87 to 17.5 MGD (ADWF), with the exceptions of the Stockton Ship Channel Turning Basin where the change is estimated to be 0.03 mg/L as N.

Table 43: Median Nitrate at Select Locations within the Delta for Project Scenarios under Critical Water Year Conditions

Location	Nitrate (mg/L as N) for WQCF ADWF (MGD)				$\Delta^{(3)}$ (mg/L)
	0.0[1]	2.1[2]	9.87	17.5	
SWP Clifton Court Intake	0.73	0.73	0.74	0.74	< 0.01
CVP DMC Intake	0.88	0.88	0.90	0.91	0.01
CCWD Intake at Rock Slough	0.53	0.53	0.53	0.53	< 0.01
CCWD Intake at Old River	0.51	0.51	0.51	0.52	0.01
San Joaquin River at Light 18	No Data				
Stockton Turning Basin	No Data				

(1) Estimated water quality at the selected location without WQCF effluent.
(2) The WQCF ADWF during the modeled critical water year was 2.1 MGD. Values listed represent the median observed at the location.
(3) Incremental change between current permitted condition (9.87 MGD (ADWF)) and proposed project (17.5 MGD (ADWF)).

Table 44: Median Nitrate at Select Locations within the Delta for Project Scenarios under Dry/Below Normal Water Year Conditions

Location	Nitrate (mg/L as N) for WQCF ADWF (MGD)				$\Delta^{(3)}$ (mg/L)
	0.0[1]	2.1[2]	9.87	17.5	
SWP Clifton Court Intake	0.40	0.40	0.40	0.41	0.01
CVP DMC Intake	No Data				
CCWD Intake at Rock Slough	0.22	0.22	0.22	0.22	< 0.01
CCWD Intake at Old River	No Data				
San Joaquin River at Light 18	0.61	0.61	0.62	0.62	< 0.01
Stockton Turning Basin	1.56	1.57	1.61	1.64	0.03

(1) Estimated water quality at the selected location without WQCF effluent.
(2) The WQCF ADWF during the modeled critical water year was 3.5 MGD. Values listed represent the median observed at the location.
(3) Incremental change between current permitted condition (9.87 MGD (ADWF)) and proposed project (17.5 MGD (ADWF)).

Comparison to Water Quality Objectives: The basis for EC water quality objectives in the Delta is the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (SWRCB, 1995). Among the far-field sites considered, EC objectives exist only for the Clifton Court and DMC Intakes. A year-round objective of 1,000 µmhos/cm applies to both export sites. The median EC levels at the two locations are well below the objective in critical water years and the incremental change in water quality due to the project is generally 1 µmho/cm or less.

There are no established water quality objectives for DOC in the Delta.

The Water Quality Objective for nitrate is from the Title 22 primary drinking water MCL of 10 mg/L as N. At all modeled far-field locations, the median nitrate levels are expected to be well below the MCL value, and changes to nitrate levels in the Delta as a result of the proposed project are estimated to be generally less than 0.02 mg/L as N.

Evaluation: The proposed project does not affect Delta water quality to a noticeable degree. Results from the hydrologic analysis indicate that implementing the proposed project will not lead to appreciable levels of WQCF effluent in the Delta. Because the WQCF effluent is of high quality, and is highly diluted by the time it reaches the Delta far-field locations of interest, the project is anticipated to have minimal impact on Delta water quality.

Implementing the proposed project is expected to have little impact on the EC levels in the Delta. Levels of DOC are not predicted to change noticeably in the Delta as a result of the project. Typical changes in DOC levels will be less than 0.01 mg/L with the biggest change being 0.04 mg/L.

In summary, only a small fraction of high quality WQCF effluent will be present throughout the Delta, thus there will be little change in Delta water quality due to implementation of the project.

SUMMARY OF WATER QUALITY IMPACTS

The wastewater treatment process upgrades recently completed as part of the WQCF Phase III expansion, including nitrification-denitrification, tertiary filtration, and ultraviolet (UV) disinfection facilities, allow the WQCF to discharge very high quality tertiary treated effluent to the San Joaquin River. The City proposes to discharge this same high quality effluent to the river at higher flowrates following Phase IV of the WQCF expansion which will increase the WQCF discharge capacity from the currently permitted 9.87 MGD (ADWF) to 17.5 MGD (ADWF).

The near-field and far-field water quality impact assessments presented in the previous two sections of this report show that the proposed increase in WQCF discharge capacity to the San Joaquin River will generally have very minor impacts on the water quality of the San Joaquin River and Delta, with the exception of a near-field exceedance of the U.S. EPA chronic ambient water quality criterion (87 µg/L) for total aluminum (USEPA, 2002). The exceedance of the aluminum water quality objective in the receiving water is the result of the ambient levels of the parameter already exceeding standards upstream of the WQCF discharge. Exceedances of Thermal Plan objectives will be mitigated as necessary (e.g., through the construction and operation as necessary of effluent cooling facilities) based on the expert opinions of fisheries biologists and involved parties charged with determining the significance of the WQCF thermal plume to migrating salmonids and other resident fish species. With regard to whole effluent toxicity testing, the past 18 months of available data following addition of nitrification-denitrification processes indicate that WQCF effluent has no adverse impact on the receiving water. Considering that the City's effluent will maintain this high water quality throughout and after implementation of the proposed project, it is projected that an increase in discharge from the WQCF will produce no adverse toxics effects in the San Joaquin River.

The City recently completed a WER study (City of Manteca, 2007) to identify an appropriate site-specific water quality objective for aluminum in the San Joaquin River that is both sufficiently protective of aquatic life and identifies available assimilative capacity for aluminum in the river under which the WQCF can discharge its effluent. The study indicates that a WER of 22.7 in scientifically defendable. To this end, the next lowest water quality standard for aluminum (Title 22 Secondary MCL of 200 µg/L) may be applicable to WQCF effluent. Title 22 Secondary MCLs are set to evaluate potable water that has received treatment, including filtration that generally removes the particulate materials from the water, leaving essentially only the dissolved fraction. However, Title 22 standards do not directly specify whether the total or dissolved phase should be considered. Applying Secondary MCLs directly to surface water warrants consideration in that only the dissolved fraction would ultimately pass through a drinking water treatment plant. While CDPH has recently stated that application of Secondary MCLs as dissolved is sufficient to protect municipal and drinking water uses, it has been the Regional Water Board's policy to apply it as a total concentration objective to be protective of taste and odor for direct consumption of San Joaquin River water. Most importantly, an increase in WQCF permitted discharge capacity from 9.87 MGD (ADWF) to 17.5 MGD (ADWF) does not negatively impact the San Joaquin River with regard to this parameter, and in fact will decrease total aluminum concentrations in the receiving water.

Results of the thermal modeling efforts verified that planned operational changes to discharge effluent only during times of positive downstream river flows will produce a plume complying with provision 5.A(1)b of the Thermal Plan. The evaluation of the modeling results against the

aquatic life thermal tolerance leads to the conclusions that the discharge plume: is relatively small; is primarily oriented near the water surface adjacent to the channel bank; would not create a barrier to fish migration within the San Joaquin River; and would not result in direct acute mortality to the fish and macroinvertebrate communities inhabiting the receiving water (RMA, 2006). Upon reviewing the findings detailed in the report, the City requested that the Regional Board grant an exception from certain provisions of the Thermal Plan for the WQCF design capacity of 9.87 MGD.

The findings of the 2006 RMA report concluded that evaluating the temperature difference as a monthly average is protective of aquatic life[4] and allows the City to meet provision 5.A(1)a. With regard to provision 5.A(1)b, modified operations will allow the City to meet this provision. With regard to provision 5.A(1)c, the area in the receiving water where its requirements are not met is sufficiently small that there are no significant adverse effects to the most sensitive species of aquatic life.

In review of the exception request the Regional Board requested an informal consultation from the National Marine Fisheries Service (NMFS). By law NMFS can not perform a formal consultation without a regulatory action by the Regional Board. Because the Regional Board did not act on the City's request, only an informal consultation could be conducted by NMFS, where the threshold for approval is no non-negligible impacts. In the exception request the City acknowledges that there is a potential for minor impacts limited to avoidance by anadromous fish species, and the NMFS cursory review indicated that in the Spring out migrating smolts potentially may be impacted as they tend to follow the outside bend near the shoreline. NMFS did not approve the exception request following the informal consultation.

With regard to the proposed WQCF Phase IV expansion from 9.87 MGD (ADWF) to 17.5 MGD (ADWF), modeling of the thermal plume led to the conclusion that the increased discharge would potentially exceed all provisions of the Thermal Plan under critical receiving water flowrates. To mitigate potential non-negligible thermal impacts of the WQCF discharge, the City intends to design, install, and operate treated effluent cooling facilities that cool treated effluent prior to discharge into the San Joaquin River at low flowrates. The cooling facilities will be designed to reduce the temperature of the treated effluent such that the effluent discharge and associated size of the thermal plume will comply with all the Thermal Plan provisions as necessary to protect sensitive aquatic life. The City request a specific operations schedule for the cooling facilities based on river flowrate and temperature differential to mitigate thermal impacts when necessary without needless operation of an energy intensive process.

The City performed investigative modeling to determine an operation envelope where the ambient river conditions would be sufficient to mitigate the WQCF thermal plume and result in non-negligible impacts to sensitive aquatic life without the use of cooling facilities. As part of the current ROWD submittal, the City is requesting a limited exception from applicable Thermal Plan provisions under ambient conditions and seasons where the resulting plume will have a negligible impact on sensitive aquatic life (Salmonids). Depending on the difference in temperature between the ambient river and effluent, at an effluent flowrate of 17.5 MGD, a river

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[4] Specifically, Salmonids, as they represent the aquatic organisms most sensitive to changes in thermal regimes.

flowrate between 2,000 and 3,000 cfs is sufficient for the effluent to comply with provision 5.A(1)b of the Thermal Plan. However, it was found that a river flowrate of greater than 12,000 cfs was necessary to submerge the outfall. Specifically, the City would request exception from the Thermal Plan provisions 5.A(1)a and 5.A(1)c in the Fall and Winter when the river flowrate was sufficient to provide compliance with 5.A(1)b, as the adult salmon and steelhead would be migrating up river along the channel bottom, unaffected by the WQCF thermal plume. When river flowrates in the Spring exceed 12,000 cfs and the outfall is submerged, the City would request exception from Thermal Plan provision 5.A(1)c as the smolts would not likely encounter the initial mixing zone where water temperature differentials may be greater than 4°F.

All other near- and far-field constituents considered in this report are expected to exhibit only slight to minor increases in concentration in the receiving water at well-mixed conditions downstream of the discharge at the proposed 17.5 MGD (ADWF) discharge capacity. With the exception of aluminum, median concentrations of modeled constituents are not anticipated to exceed relevant water quality objectives, and on average are estimated to be present at concentrations well below objectives.

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Assessment of Socio-Economic Considerations

The public benefit derived from an increase in WQCF discharge capacity that is necessary to accommodate growth in the City and the surrounding area is an important consideration in this antidegradation analysis. In accordance with APU 90-004 guidance for a 'complete' antidegradation analysis, the following factors are considered in determining whether the lowering of water quality that is anticipated with the WQCF expansion is necessary to accommodate economic or social development and is consistent with maximum public benefit:

- A consideration of alternative control measures that might reduce, eliminate, or compensate for the water quality impacts of the proposed capacity increase;

- An evaluation of each alternative control measure for costs, impacts on water quality, and compliance with applicable laws, regulations, and policies;

- An assessment of the socio-economic impacts of each alternative; and

- A balancing of the proposed WQCF expansion and the alternatives based on environmental and socio-economic considerations.

COSTS AND BENEFITS OF ALTERNATIVES FOR MAINTAINING EXISTING WATER QUALITY

The first component of the antidegradation analysis, the assessment of projected water quality impacts due to the proposed project, identified constituents that, to varying degrees, may impact water quality in the San Joaquin River (downstream of the WQCF discharge) and in the Delta due to an increase in WQCF discharge. Maintaining existing water quality in the San Joaquin River and the Delta with an increase in WQCF discharge may be approached through effluent-to-land disposal or additional wastewater treatment by microfiltration and reverse osmosis (MF/RO). Each of these alternatives possesses unique abilities to address water quality constituents of concern and each has distinct implementation benefits, liabilities, and costs. In order to maintain existing water quality and mass loading in the San Joaquin River from the time the WQCF reaches its current permitted capacity of 9.87 MGD (AWDF) through the proposed Phase IV build-out capacity of 17.5 MGD (ADWF), it is estimated that a maximum effluent-to-land disposal capacity of 8 MGD or a maximum MF/RO capacity of 7.3 MGD would be required. The implementation of either alternative would maintain WQCF effluent mass loading to the San Joaquin River at the currently permitted 9.87 MGD (ADWF) level as WQCF discharge capacity increases to 17.5 MGD (ADWF).

The costs of implementing either the effluent-to-land disposal or MF/RO alternative control measure would be above and beyond the Phase IV costs associated with increasing WQCF discharge capacity to 17.5 MGD (ADWF). In accordance with the City's Public Facilities Implementation Plan (Nolte, 2008), the construction costs of the Phase IV expansion would be borne by future WQCF ratepayers whose wastewater service needs are prompting the proposed 7.63 MGD (ADWF) discharge capacity increase. The construction costs associated with the Phase IV expansion would be paid for by developers in the form of increased connection fees that would be used by the City to service the debt incurred from the construction of the Phase IV Expansion Project. These increased connection fees would be passed along by the developer to new home buyers in the cost of a new home. Similarly, these fees would also be passed along to new commercial and industrial enterprises. It is estimated that these future ratepayers would be

assessed a one-time fee of approximately $4500[5] built into the cost of purchasing or leasing a piece of property. It should be noted that existing households, businesses, and industry within existing developed areas of the City would not be assessed an additional fee to provide funding for the Phase IV expansion construction costs. Operations and maintenance (O&M) costs for an expanded 17.5 MGD (ADWF) WQCF would be shared among all ratepayers, with new development funding the proportion of O&M costs associated with the proposed 7.63 MGD (ADWF) discharge capacity increase.

Consistent with the City's Public Facilities Implementation Plan (Nolte, 2008), the City would look to future residential and non-residential ratepayers to fund construction and operation and maintenance costs of an alternative control measure. Specifically, the City would look to future residential ratepayers to pay for 60 percent and future non-residential ratepayers to pay for 40 percent of an alternative's implementation costs. The 60/40 split between residential and non-residential ratepayers reflects the fact that approximately 60 percent of WQCF wastewater treatment capacity is allocated to residential customers. For the purpose of the present analysis, the residential category represents only City residential customers and the "non-residential" category includes City commercial, industrial, and septage users, as well as wastewater[6] received from the City of Lathrop and Raymus Village. Forty (40) percent of WQCF wastewater treatment capacity is allocated to this "non-residential" group of customers. The present analysis is based on the assumption that effluent flow in excess of 9.87 MGD (ADWF) would need to be accommodated by either effluent-to-land disposal or MF/RO advanced treatment as a means of maintaining WQCF mass loading to the San Joaquin River at the currently permitted 9.87 MGD (ADWF). It is anticipated that the City will not need to discharge greater than 9.87 MGD (ADWF) to the San Joaquin River until sometime between the years 2012 to 2017. The proposed sharing of alternative control measure costs among future residential and non-residential ratepayers is provided in **Table 45**. In the present analysis, total costs include capital and O&M costs, and all cost estimates are presented as *planning level estimates* provided in present worth dollars as of March 2008. Annualized total costs are based on a 20-year period and a 6 percent discount rate (annualization factor = 0.08718).

Table 45: Alternative Control Measure Cost Sharing among WQCF Ratepayer Groups

WQCF Ratepayer Group by Sewage Type Contribution	WQCF Ratepayer Group by User History	
	Current Users	Future Users
Residential Users (*60% WQCF capacity allocation*)	0%	60%
Non-Residential Users (*40% WQCF capacity allocation*)	0%	40%

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[5] Estimated one-time fee assumes no markup by developer.

[6] Wastewater received from the City of Lathrop and Raymus Village is primarily composed of domestic waste; however, for the purpose of the current analysis the residential customers generating domestic waste in the City of Lathrop and Raymus Village are grouped in the "non-residential" ratepayer category in order to separate their domestic waste contributions from those of City of Manteca residential customers.

Effluent-to-Land Disposal

The use of recycled water for unrestricted urban landscape irrigation and agricultural irrigation represent alternatives for treated wastewater disposal for the City. Effluent from the WQCF is currently either land applied to approximately 360 acres of City-owned/leased parcels or discharged to the San Joaquin River. The City has examined a number of effluent-to-land disposal strategies that would have sufficient capacity for disposal of 8 MGD of treated wastewater year-round. Because of the relatively high unit cost and other implementation constraints of urban water reuse, the City has decided to direct land disposal of undisinfected, denitrified, secondary effluent to existing City-owned land surrounding the WQCF and to future City-purchased land at some distance from the WQCF. While the City has examined the costs of purchasing land from one to 10 miles away from the WQCF for effluent disposal (Nolte, 2004), economic considerations and land availability make the purchase of land farther away from the WQCF a more tenable proposition for the City. To this end, the effluent-to-land disposal strategy selected for consideration under the current economic impact analysis includes high-rate irrigation (260 in/yr) of City-owned land at the WQCF (4,600 ac-ft/year or 4.11 MGD) and agricultural irrigation (60 in/yr) on acreage within approximately 10 miles from the WQCF that would be purchased by the City (4,360 ac-ft/year or 3.89 MGD) as a means of collectively applying 8 MGD of undisinfected, denitrified, secondary effluent to land when such application is permissible. During the wet season when land application is prohibited or not practicable, depending on amount and timing of seasonal rainfall, the City's treated effluent would be held in lined storage ponds until land application could resume.

Costs

The selection of high-rate irrigation of existing City-owned land along with agricultural irrigation of future City-purchased land represents a moderately priced land application strategy from a cost perspective. The effluent-to-land disposal costs provided in **Table 46** are planning levels estimates intended to provide the reader with cost estimates that allow a cost comparison between the two treatment alternatives presented in this report. **Table 46** presents various costs associated with the implementation of an 8 MGD effluent-to-land application operation. In addition to total project costs, the costs of this alternative are divided among future residential and non-residential ratepayers. If the City was required to treat WQCF effluent to the tertiary level prior to land application, then the costs provided in **Table 46** would significantly increase as a result of increased operation and maintenance costs associated with tertiary wastewater treatment.

Table 46: Effluent-to-Land Disposal Cost Estimates by Ratepayer Group Allocation for 8 MGD Disposal Capacity

Ratepayer Group	Capital Cost[1]	Annualized Capital Cost	Annual Operations and Maintenance Cost[1]	Total Annual Cost
Future Residential	$17,100,000	$1,500,000	$180,000	$1,680,000
Future Non-Residential	$11,400,000	$1,000,000	$120,000	$1,120,000
Totals	**$28,500,000**	**$2,500,000**	**$300,000**	**$8,800,000**

(1) Estimated March 2008 costs based on adjusted 2002 costs provided in Nolte, 2004.

Benefits

Effluent-to-land disposal would allow the reclamation of up to approximately 46 percent of WQCF effluent at the proposed build-out capacity of 17.5 MGD (ADWF) and would provide an additional water supply source to the region. Limiting the discharge of tertiary treated effluent to the San Joaquin River at 9.87 MGD (ADWF) would maintain existing water quality and mass loading in the river at currently permitted levels while the WQCF attained its proposed build-out capacity of 17.5 MGD (ADWF).

Potential Impacts

Potential environmental impacts related to the effluent-to-land disposal alternative include potential impacts from the addition of salts and minerals of local concern to regional groundwater supplies, the possibility of groundwater mounding in the area(s) of land application, and temporary construction-related impacts. Additionally, increased air emissions would result from increased power consumption[7] needed to pump secondary effluent to storage ponds and then to land application sites. This increase in greenhouse gas emissions would significantly expand the carbon footprint of the WQCF and runs contrary to Assembly Bill 32 (AB 32) – the California Global Warming Solutions Act of 2006 – that seeks to establish a statewide greenhouse gases emission cap for 2020 based on California's 1990 emission levels. Potential effluent-to-land disposal environmental impacts are provided in **Table 47**. Elevated groundwater TDS concentrations in the Eastern San Joaquin Valley groundwater subbasin are the result of natural weathering of Coast Range marine sedimentary rocks and decades of agricultural irrigation (USGS, 1995). Evaporation of sprayed irrigation water and evapotranspiration of soil moisture and shallow groundwater leaves behind dissolved salts. Land application of treated secondary effluent could further elevate local TDS concentrations in groundwater. Groundwater mounding, as observed in the Kings and Turlock groundwater subbasins (DWR, 2003), could occur if effluent was applied to areas of low or insufficient hydraulic conductivity. Temporary, construction-related impacts associated with the building of a water conveyance and storage system for treated effluent at some distance from the WQCF are anticipated. However, these temporary, construction-related impacts would be mitigated to the greatest extent practicable.

Table 47: Potential Environmental Impacts Associated with Effluent-to-Land Disposal

Potential Effluent-to-Land Disposal Environmental Impacts
Addition of salts (as measured by TDS) to groundwater at a concentration greater than the Title 22 Secondary MCL recommended level[1] of 500 mg/L, or greater than ambient background quality.
Groundwater mounding in the area(s) of land application.
Increases in energy consumption and greenhouse gas emissions due to substantial power requirements of pumping effluent to storage ponds and then to site(s) of land application.

(1) 500 mg/L is the low end of the acceptable Title 22 Secondary MCL range for TDS.

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[7] Although significant energy would be required to treat effluent with tertiary filtration, a larger amount of energy would be consumed by pumping the same volume of secondary effluent a distance of 10 miles.

Compliance with Laws and Regulations

State and federal water quality laws require that discharges not result in an exceedance of water quality standards. Effluent-to-land disposal and storage pond operations would comply with waste discharge requirements set forth by the Regional Water Board. Near-field exceedances of the allowable Title 22 Secondary MCL range for TDS (500 – 1000 mg/L) are not expected to occur. No far-field exceedances of water quality objectives are expected to occur as the result of effluent-to-land disposal.

Microfiltration and Reverse Osmosis

As a result of the WQCF's completed Phase III improvements (including nitrification-denitrification, tertiary filtration, and UV disinfection facilities), the remaining advanced wastewater treatment options available to the City are microfiltration and reverse osmosis. RO is a membrane separation process that is used for the removal of dissolved constituents from wastewater remaining after advanced treatment with tertiary filtration or microfiltration (Metcalf and Eddy, 2003). RO treatment relies on applied pressure to force water through a semi-permeable membrane while restraining the passage of particulate and high molecular weight constituents. Membranes exclude ions, but require high pressures to produce the deionized water (Metcalf and Eddy, 2003). Passage of water through the membrane produces a relatively ion free effluent stream and a concentrated brine stream. MF occurs prior to RO in order to remove larger organic and inorganic particles that foul the RO membrane and thus increase membrane resistance to water flow and reduce membrane service life. RO is a very energy intensive process that produces a toxic brine concentrate that poses its own waste disposal issues. In regard to pollutants of concern contained in WQCF effluent, RO would reduce concentrations of TDS, metals, ammonia, and organic compounds, and would lower EC. An estimated, future maximum MF/RO capacity of 7.3 MGD considered in the current analysis is based on the volume of effluent that would require MF/RO treatment when the WQCF reaches its proposed build-out capacity of 17.5 MGD (ADWF) in order to maintain TDS mass loadings in WQCF effluent at the currently permitted 9.87 MGD (ADWF) level. MF/RO treatment of 7.3 MGD of WQCF tertiary treated effluent would produce approximately 1.5 MGD of brine that would require disposal. This analysis assumes that the blending of effluent streams of different qualities is permitted, and therefore only a portion of WQCF tertiary effluent would need to undergo MF/RO prior to blending with non-MF/RO tertiary effluent subsequent to discharge to the San Joaquin River.

Costs

The MF/RO costs provided in **Table 48** are planning levels estimates that allow a cost comparison between the two treatment alternatives presented in this report. MF/RO cost estimates assumed 75 percent recovery for the treatment process with effluent making two passes through membranes. The estimates include the on-site cost of controlled thermal evaporation or crystallization of brine and its ultimate disposal in a local landfill. Depending on the nature of the brine and residuals produced by MF/RO treatment of WQCF effluent, the need for additional treatment to remove heavy metals and other toxic contaminants from the brine and/or more limited disposal options of residuals could significantly increase the ultimate cost of MF/RO above those costs provided herein. **Table 48** presents various costs associated with the construction and operation of MF/RO facilities having a treatment capacity of 7.3 MGD. In

addition to total project costs, the costs of this alternative are divided among future residential and non-residential ratepayers.

Table 48: Microfiltration and Reverse Osmosis Cost Estimates by Ratepayer Group Allocation for 7.3 MGD Treatment Capacity

Ratepayer Group	Capital Cost[1,2]	Annualized Capital Cost	Annual Operations and Maintenance Cost[1]	Total Annual Cost
Future Residential	$56,100,000	$4,900,000	$2,900,000	$7,800,000
Future Non-Residential	$37,400,000	$3,200,000	$2,000,000	$5,200,000
Totals	**$93,500,000**	**$8,100,000**	**$4,900,000**	**$13,000,000**

(1) Estimated March 2008 costs at ENRCCI 8109 based on adjusted 2007 costs provided in LWA, 2007.
(2) Project costs include engineering, administrative, legal, and contingency costs.

Benefits

MF/RO of a portion of WQCF tertiary treated effluent would provide sufficient removal of pollutants of concern from blended MF/RO and non-MF/RO WQCF effluent discharged to the San Joaquin River so as to maintain existing water quality and mass loading in the river at pre-project levels (i.e., maintain water quality and mass loading at the currently permitted 9.87 MGD (ADWF) level). However, it should be noted that MF/RO treatment would not significantly lower downstream water quality concentrations in the receiving water.

Potential Impacts

Advanced wastewater treatment employing MF/RO generates a significant level of concern due to energy demand and "cross media impacts" – this term refers to the interrelated impacts caused by removal of a pollutant from one medium and its transfer to one or more other media. In the case of MF/RO, the process removes a pollutant at a certain concentration from wastewater and partitions it at a significantly higher concentration in brine and/or residuals. Pollutants, such as metals, are not destroyed, but transferred from one medium to another. Organic pollutants can be destroyed or converted to other toxic or non-toxic forms and can also be transferred from one medium to another. It should be noted that in transferring from one medium to another, the bioavailability of the pollutant may be changed significantly. MF/RO treatment results in the transfer of pollutants from wastewater into biosolids, air, and/or concentrated waste streams. Depending on regulatory limits, additional treatment of the biosolids, air, or waste streams may be required (Carollo, 2005). In addition to these cross media pollutant transfer impacts, operation of MF/RO processes can generate additional pollutants and greatly elevate local power demand as described by the potential MF/RO environmental impacts provided in **Table 49**. Increased power consumption would lead to increases in greenhouse gas emissions that would significantly expand the carbon footprint of the WQCF. This increase in greenhouse gas emissions runs contrary to Assembly Bill 32 (AB 32) – the California Global Warming Solutions Act of 2006 – that seeks to establish a statewide greenhouse gases emission cap for 2020 based on California's 1990 emission levels. Finally, temporary, construction-related impacts associated with the building of MF/RO treatment facilities are anticipated for this alternative

control measure. However, these temporary, construction-related impacts would be mitigated to the greatest extent practicable.

Table 49: Potential Environmental Impacts Associated with Microfiltration/Reverse Osmosis Treatment of Wastewater

Potential MF/RO Environmental Impacts[1]
Substantial power requirements of MF/RO treatment and associated increases in greenhouse gas emissions from the power plants providing the electricity.
Potential need for additional treatment of brine waste to remove heavy metals and other contaminants from the aqueous phase prior to crystallization and disposal of waste.
Ultimate disposal of brine and residuals requiring the energy intensive processes of evaporation, crystallization, and off-site transport.
Increases in greenhouse gas emissions from truck and rail traffic to dispose of crystallized brine waste.

(1) Metcalf and Eddy, 2003.

Compliance with Laws and Regulations

State and federal water quality laws require that discharges not result in an exceedance of water quality standards. The portion of WQCF effluent that would undergo MF/RO treatment is expected to meet all relevant water quality objectives and standards, with the possible exception of Thermal Plan objectives. Any non-negligible, near-field thermal impacts would be mitigated as necessary (e.g., implementation of cooling facilities to lower effluent temperature prior to its discharge into the San Joaquin River) as part of the WQCF's overall compliance with the Thermal Plan. However, where the thermal plume does not impose any non-negligible impacts to aquatic life, the City is seeking an exception from Thermal Plan provisions. The MF/RO treatment alternative is not expected to result in far-field exceedances of applicable water quality objectives or standards.

SOCIO-ECONOMIC IMPACTS OF ALTERNATIVES FOR MAINTAINING EXISTING WATER QUALITY

As described in the previous section, the analysis of costs, benefits, and potential impacts of maintaining existing surface water quality in the San Joaquin River by maintaining WQCF effluent mass loading to the river at the currently permitted 9.87 MGD (ADWF) level as WQCF discharge capacity increases to 17.5 MGD (ADWF) is based on two potential alternatives: effluent-to-land disposal and MF/RO. Both of these alternative control measures will result in a substantial increase in monthly sewer service fees paid by users of the City's treatment facilities. Furthermore, the annual costs of each alternative, and their associated monthly sewer rate increases, can be translated into a set of economic indicators that describe revenue and employment losses in the WQCF service area as a means of modeling the overall socio-economic cost of implementing and operating either alternative control measure. As a means of limiting the number of projections made in the course of estimating alternative control measure project costs and impacts to ratepayers in the WQCF service area, a decision was made to estimate all costs and impacts in present worth dollars (as of March 2008) and apply them to a

projected 16,956[8] households that would receive wastewater treatment services as a result of the proposed 7.63 MGD (ADWF) WQCF discharge capacity increase. The following sections discuss the impacts of each alternative in terms of monthly sewer rate increases and overall socio-economic impacts to the WQCF service area.

Impacts on Monthly Residential Sewer Rates

The current analysis of monthly sewer rate increases that would be associated with the construction and operation of the two alternative control measures is focused on increases to future residential ratepayers. An analysis of fee increases to future non-residential ratepayers is outside the scope of the current effort; however, socio-economic impacts to all future ratepayer categories are considered in the following section (*Modeling of Economic Impacts on the Community*). Limiting the current discussion to increases in residential ratepayer fees follows the common practice of estimating the economic impact of a project on the *average household* within a community. The effluent-to-land disposal and MF/RO project costs presented in **Table 46** and **Table 48**, respectively, can be used to estimate a monthly sewer rate increase that would be assessed to future residential ratepayers was an alternative to be implemented today, as shown in **Table 50**. Based on the current monthly residential sewer fee[9] of $33.06 (as of March 2008), customers in this rate category would pay monthly fees of $41.32 or $71.39, respectively, if an effluent-to-land disposal or MF/RO control measure was implemented today. It is important to note that these estimated monthly fee increases represent only the portion of an alternative's cost assessed to future residential ratepayers to pay for 60 percent of the construction and O&M costs of an alternative control measure (see **Table 45**).

Table 50: Estimated Monthly and Annual Residential Sewer Rate Increases assessed to Future Ratepayers to provide Debt Service and O&M for Alternative Control Measures

Alternative Control Measure	Future Residential Ratepayer Share of Total Annual Project Cost	Estimated Future Residential Sewer Fee Increases	
		Monthly Increase	Annual Increase
Effluent-to-Land Disposal	$1,680,000	$8.26	$99.12
Microfiltration/Reverse Osmosis	$7,800,000	$38.33	$459.96

The monthly sewer rate increases shown in **Table 50** that would be assessed to future residential ratepayers was an alternative control measure to be implemented would provide debt service and O&M funding for only 60 percent of the total cost of an alternative. The remaining 40 percent of an alternative's cost would be borne by future non-residential ratepayers as shown in **Table 51**. These future non-residential ratepayers would also see their monthly sewer fees increased; however, a detailed accounting and projection of monthly rate increases for future City

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[8] The estimate of 16,956 future residential ratepayers represents 60 percent of the total number (28,259) of equivalent dwelling units (EDUs) receiving wastewater treatment services as a result of the proposed 7.63 MGD (ADWF) WQCF discharge capacity increase (7.63 MGD/270 gpd per EDU = 28,259 EDUs).

[9] Current sewer fees cover the cost of Phase III improvements and O&M for a WQCF treatment capacity of 9.87 MGD.

commercial, industrial, and septage users, as well as customers in the City of Lathrop and Raymus Village is outside the scope of the current effort. As stated above, a consolidated assessment (residential *plus* non-residential impacts) of alternative control measure costs to future WQCF ratepayers in terms of overall economic impact to the WQCF service area is provided in the following section (*Modeling of Economic Impacts on the Community*).

Table 51: Estimated Annual Debt Service and O&M Costs assessed to Future Non-Residential Ratepayers in WQCF Service Area

	Annual Debt Service[1] and O&M Costs by Alternative		
Ratepayer Group	Effluent-to-Land Disposal	Microfiltration and Reverse Osmosis	Debt Service and O&M Revenue Source
Future Non-Residential	$1,120,000	$5,200,000	Increased monthly sewer fees

(1) Debt amortized over a 20-year period with an annualization factor of 0.08718.

Socio-Economic Impacts to the WQCF Service Area

Socio-economic impacts to the WQCF service area as a result of implementing an alternative control measure are assessed at two levels: (1) impacts on individual households due to sewer fee increases, and (2) impacts on the community based on a modeling of key economic indicators. As stated earlier, the estimating of alternative control measure costs and impacts to future residential ratepayers in the WQCF service area was made in present worth dollars (as of March 2008) and applied to an estimated 16,956 households as a means to reduce the total number of assumptions made in the course of making the estimates. This strategy avoids the uncertainties associated with an estimate based on future population growth in and around the City, future construction costs, and the precise timing of alternative control measure implementation. While it is true that alternative control measures, if pursued, would not be implemented until 2012 to 2017, and projects costs would be greater at that time, household incomes would also increase, thus maintaining the relative economic burden of an alternative control measure relatively constant over the next several years. The economic impact analysis software used to model economic impacts to the WQCF service area due to the implementation of alternative control measures relies on the distribution of wealth in the community and the spending habits of Manteca's citizens in order to project changes in several key economic indicators. The current distribution of wealth, spending habits, and overall economic health of the City are not anticipated to significantly change in the next five to 10 years, further supporting the use of 2008 project cost estimates to assess the general economic burden imposed by the implementation of effluent-to-land disposal or MF/RO on the City.

Projected Increases in WQCF Residential Rates with Implementation of Alternative Control Measures

The WQCF service area's current residential monthly sewer fee is $33.06. Monthly residential sewer rate increases estimated for the two alternative control measures necessary to maintain WQCF effluent mass loading to the San Joaquin River at the currently permitted 9.87 MGD (ADWF) level as WQCF discharge capacity increases to 17.5 MGD (ADWF) will bring total monthly fees to $41.32 for the effluent-to-land disposal alternative and to $71.39 for the MF/RO

alternative (see **Table 52**). As stated earlier, the estimated monthly fees charged to future residential ratepayers will only support repayment of 60 percent of the total cost of an alternative. The estimated $495.84 and $856.68 annual sewer fees (for effluent-to-land disposal and MR/RO, respectively) shown in **Table 52** only apply to future residential ratepayers and do not reflect the increased sewer fees to be paid by future non-residential customers in the City's new development areas or by future ratepayers in the City of Lathrop and Raymus Village. If implemented, the effluent-to-land disposal alternative would produce a 25 percent increase in the sewer fees paid by future residential ratepayers in the City's new development areas as compared to fees paid by existing residential ratepayers. Implementation of the MF/RO alternative would result in future residential sewer fees in new development areas being almost 116 percent higher, on a percentage-above-current cost basis, than fees paid by existing residential ratepayers. Depending on how quickly Manteca's population grows and how many years the City ultimately decides to amortize an alternative control measure's cost over, the cost of supporting repayment of an alternative control measure could increase above those estimated in the current analysis. If alternative control measure debt service and O&M funding fell short of meeting the City's financial obligations, then additional sewer rate increases would likely be levied against ratepayers in new development areas.

Table 52: Comparison of Current WQCF Treatment Cost to Estimated Costs for Alternative Control Measures

Treatment Level	Monthly Residential Fee	Annual Residential Fee	% Increase in Treatment Cost above Current Level
Current Treatment	$33.06	$396.72	--
Effluent-to-Land Disposal	$41.32[1]	$495.84[1]	25.0%
Microfiltration/Reverse Osmosis	$71.39[1]	$856.68[1]	115.9%

(1) Estimated fee.

Modeling of Economic Impacts on the Community

An economic impact analysis traces spending through an economy and measures the cumulative effects of that spending. The impact region can be an entire state, one or more counties, a single city, or any segment of the population representing a semi self-sufficient economic unit for which relevant economic information exists. The current economic impact analysis evaluates the potential impacts to the City due to an increase in annual sewer fees that would be needed to finance the two alternative water quality control measures presented in this section. An economic impact modeling software package, IMPLAN® (IMpact Analysis for PLANing) Version 2, was used to estimate the socio-economic impacts of increased sewer fees on City residents from a broader perspective, beyond the single economic metric of an annual rate increase. IMPLAN® is a widely accepted model that has been used by the US EPA, the California Department of Water Resources, USDA Forest Service, and USDI Bureau of Land Management. IMPLAN® is an economic impact assessment modeling system that allows the user to build models to estimate the impacts of economic changes at state, county, or community levels. For the current analysis, economic data specific to the City of Manteca were obtained from the Minnesota IMPLAN® Group, Inc. (MIG), based on zip codes within the City (95336 and 95337).

IMPLAN® is an input-output model that uses multipliers[10] to represent demand and flow of resources among sectors[11] and institutions in the economy. Input-output analysis is a means of examining relationships within an economy, both between businesses and between businesses and final consumers. It captures all monetary market transactions for consumption in a given time period. This type of analysis allows examination of the effects – or economic impacts – of a change in one or several economic activities on an entire community. Economic impacts are represented by changes in economic output and employment. The current analysis is based on the assumption that a sewer fee increase to households in the WQCF service area will reduce discretionary spending of disposable income. A loss in discretionary spending will reduce demands for local goods and services, which in turn will reduce demands for local labor, resulting in loss of employment.

Unlike the ratepayer category effects presented in **Table 45** where alternative costs are divided among future residential and non-residential ratepayer groups, the economic impact analysis using IMPLAN® considers the impacts of the entirety of an alternative control measure on the City as a whole. Even though the IMPLAN® model uses data only from Manteca, ratepayers from the City of Lathrop and Raymus Village were assumed to be part of the impacted community. While it is true that alternative control measures, if pursued, would not be implemented until 2012 – 2017, and projects costs would be greater at that time, household incomes would also increase, thus maintaining the relative economic burden of an alternative control measure comparatively constant over the next several years. The IMPLAN® model utilizes information regarding the distribution of wealth and spending habits in the City to estimate changes in several key economic indicators. The current distribution of wealth, spending habits, and overall economic health of the City are not anticipated to significantly change in the next five to 10 years, further supporting the use of 2008 project cost estimates to access the general economic burden imposed by the implementation of effluent-to-land disposal or MF/RO on the City. In short, the current economic impact analysis looks at present day economic effects of the entire cost of an alternative control measure on all WQCF ratepayers. While the construction and O&M costs of an alternative control measure are to be borne by future ratepayers in the City's new development areas, impacts to these ratepayers will affect the City's economy as a whole, and thus it is reasonable to use IMPLAN® to model economic impacts on a city-wide basis.

IMPLAN® data from 2006 were the most recent economic data available for the City, as compiled by MIG, and were used in the current analysis. As a means of equating 2006 model data to 2008 project costs, 2008 inflators were applied to model data to account for the change in the actual value of the dollar over the 2-year period. Basic 2006 economic information for the City used by the IMPLAN® model is shown in **Table 53**. The largest household (HH) income class in the community is the 50 – 75K group representing 24 percent of the total community. If one uses the U.S. Census Bureau's 2002 offering of "middle class" as the middle 20 percent of the country having incomes ranging from $40,000 – $95,000, then roughly 56 percent of Manteca's residents could be described as belonging to the "middle class" (this grouping

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[10] Multipliers describe the response of an economy to a stimulus (a change in demand or production).

[11] A sector represents an economic activity that produces goods and/or services. Fruit farming, natural gas distribution, real estate, and medical practices, to name but a few, all represent economic activities, and hence sectors in an economy.

includes members of the 25 – 35K, 35 – 50K, and 50 – 75K HH income classes). This leaves the City with approximately 22 percent representation in the "lower class" and about 22 percent representation in the "upper class". As shown by **Table 53**, low and middle income households would contribute the vast majority (approximately 78 percent) of financing for any required alternative control measure.

Table 53: Summary of Household Income Classes in the City of Manteca and their Relative Contributions to Alternative Control Measure Annual Costs

HH Income Class[1]	Average Annual HH Income[2,3,4]	No. of HH in Class[4]	Percent of Total HH	Relative Annual Contribution to Alternative Cost by HH Income Class	
				Effluent-to-Land Disposal	Microfiltration/ Reverse Osmosis
<10K	$7,874	1,363	6%	$100,800	$468,000
10 – 15K	$19,684	919	4%	$67,200	$312,000
15 – 25K	$31,495	2,561	12%	$201,600	$936,000
25 – 35K	$47,242	2,823	13%	$218,400	$1,014,000
35 – 50K	$66,926	4,224	19%	$319,200	$1,482,000
50 – 75K	$110,232	5,389	24%	$403,200	$1,872,000
75 – 100K	$141,727	2,562	12%	$201,600	$936,000
100 – 150K	$196,843	1,862	8%	$134,400	$624,000
150K+	$314,948	540	2%	$33,600	$156,000

HH = Households
(1) HH income class is based on median monetary income (money income) data collected by the U.S. Census Bureau.
(2) Average annual household income is based on average personal income data collected by the U.S. Bureau of Economic Analysis.
(3) Due to the manner in which average annual household income is calculated, it commonly falls above the upper boundary of the household income class to which it is associated. The difference lays in the definition of personal income versus money income.
(4) Data source IMPLAN® 2006.

The annual financial burden on lower income households of financing an alternative control measure (see **Table 52**) would result in proportionately less disposable personal income (DPI; a percentage of total average income) available to these households as compared to middle and upper income classes as presented in **Table 54**. DPI represents "after tax" income and is considered as 82.5 percent of average annual income by the IMPLAN® model. A decrease in disposable income translates into fewer dollars available to spend on essential goods and services such as food, lodging, and healthcare. An increase in annual sewer fees due to the implementation of effluent-to-land disposal would result in households in the < 10K income class spending about 7.6 percent of their average annual DPI on sewer treatment (see **Table 54**). This same income class would spend almost 13.2 percent of its average annual DPI on sewer treatment with the implementation of the MF/RO alternative. It is clear that increased monthly sewer fees due to the implementation of either alternative control measure would result in proportionately larger financial burdens to lower household income classes as compared to middle and upper income classes. However, the estimated, annual residential sewer fees provided in **Table 52** upon which the percentages provided in **Table 54** are based do not address fee increases to future non-residential ratepayers. An estimation of financial impacts to this

ratepayer group in terms of projected sewer rate increases is beyond the scope of the current effort, but community level socio-economic impacts to all ratepayer groups are considered in aggregate by the IMPLAN® model. It should be noted that DPI reductions by household income class (presented in **Table 54** as percent of DPI by treatment level) resulting from increased sewer fees do not include the additional pollution control costs paid by all households for stormwater treatment, solid waste disposal, and drinking water service.

Table 54: Percent Household Income and Average Annual Disposable Personal Income by Household Income Class Required to Finance Alternative Control Measure Costs

HH Income Class	Average Annual Disposable Personal Income (DPI)[1,2]	Annual Sewer Fee by Treatment Level as Percentage of Average Annual Household Income (HHI) and Annual Average Disposal Personal Income (DPI)					
		Current Treatment ($396.72)		ETLD Treatment ($495.84)		MF/RO Treatment ($856.68)	
		% of HHI	% of DPI	% of HHI	% of DPI	% of HHI	% of DPI
<10K	$6,496	5.04	6.11	6.30	7.63	10.88	13.19
10 – 15K	$16,239	2.02	2.44	2.52	3.05	4.35	5.28
15 – 25K	$25,983	1.26	1.53	1.57	1.91	2.72	3.30
25 – 35K	$38,975	0.84	1.02	1.05	1.27	1.81	2.20
35 – 50K	$55,214	0.59	0.72	0.74	0.90	1.28	1.55
50 – 75K	$90,941	0.36	0.44	0.45	0.55	0.78	0.94
75 – 100K	$116,925	0.28	0.34	0.35	0.42	0.60	0.73
100 – 150K	$162,395	0.20	0.24	0.25	0.31	0.44	0.53
150K+	$259,832	0.13	0.15	0.16	0.19	0.27	0.33

ETLD = Effluent-to-Land Disposal
(1) Calculated as 82.5% of Average Annual HH Income provided in Table 54.
(2) Data source IMPLAN® 2006.

Table 55 presents the IMPLAN®-modeled economic impacts of each treatment alternative in terms of labor income loss, indirect business tax loss, employment loss, and total output loss. Labor income constitutes the wages and benefits of employees and proprietors, and indirect business tax includes the excise and sales taxes paid by individuals and businesses. Total output is the sum of all the goods and services produced in a community's economy. The IMPLAN® model was run using the 50 – 75K income class as a surrogate for all income classes as the spending habits of the 50 – 75K income class have been found to be representative of the spending habits of all income classes within a community. The losses projected by the model (i.e., model output) are the sum of all direct, indirect, and induced effects of the cost of an alternative control measure on the City's economy. The model input is the estimated total annual cost for a particular alternative control measure (see **Table 46** and **Table 48** for cost estimates).

Table 55: Annualized Socio-Economic Impacts of Increased Sewer Fees Required to Finance Alternative Control Measure Costs

Alternative Control Measure	Estimated Annual Sewer Fee Increase[1]	Economic Indicators[2]			
		Labor Income Loss	Indirect Business Tax Loss	Employment Loss	Total Output Loss
Effluent-to-Land Disposal	$99.12	$581,113	$132,259	16.7 jobs	$3,159,644
Microfiltration and Reverse Osmosis	$459.96	$2,698,025	$614,061	77.7 jobs	$14,669,773

(1) Reflects only estimated increase in future residential ratepayer annual fee above current annual fee of $396.72.
(2) Considers annual losses to the community due to the entire cost of an alternative control measure.

As shown by the economic indicators provided in **Table 55**, the effluent-to-land disposal and MF/RO alternatives are projected to have widely different impacts on the City's local economy. Even though an alternative control measure would be funded exclusively by new development in the City's service area, the IMPLAN® model estimates impacts across the entire community. This dispensation is reasonable considering the interconnectivity of home owners and businesses in new development areas to the greater economy of the entire community. Because the economic indicators summarized in **Table 55** represent only a single year's impacts on the City's economy – they are, in fact, *annualized* economic indicators – these impacts would be repeated every year for the 20-year life-cycle of the alternative. The losses, whether in dollars or jobs, are linked to a reduction in DPI due to increased sewer fees required to pay for an alternative control measure. All communities possess somewhat unique spending habits as a whole, and a reduction in DPI has different consequences for some economic sectors as compared to others depending on the community in which the reduction in DPI occurs. The IMPLAN® model output also includes a listing of affected sectors for each economic indicator. The Top 10 sectors in the City projected to be affected by the implementation of alternative control measures in terms of both losses in employment and labor income are shown in **Table 56**. The sectors hit hardest by employment loss are not necessarily the same ones projected to have the greatest impact on loss of income labor because a smaller number of medium to high paying jobs (for example, health care industry jobs) will have a greater impact on a community's labor income than a larger number of low paying jobs (for example, food service jobs).

Table 56: Top 10 Sectors Affected by Implementation of Alternative Control Measures

Top 10 Affected Employment Sectors[1]	Top 10 Affected Labor Income Sectors[1]
Food service and drinking places	Hospitals
Health care offices	Health care offices
Hospitals	Food service and drinking places
General merchandise stores	Motor vehicle and parts dealers
Non-store retailers (includes internet retailers)	Wholesale trade
Food and beverage stores	Food and beverage stores
Motor vehicle and parts dealers	General merchandise stores
Real estate	Nursing and residential care facilities
Nursing and residential care facilities	Real estate
Wholesale trade	Monetary authorities and depository credit intermediation (banks, savings institutions, credit unions, etc.)

(1) Taken from IMPLAN® model output.

In terms of the impact to the current unemployment rate in Manteca (8.6% as February 2008), implementation of the effluent-to-land disposal alternative would slightly increase the overall unemployment rate in the City to 8.7 percent. The implementation of MF/RO treatment would increase the overall unemployment rate in the City to 8.9 percent. While these incremental increases in unemployment rate may appear small, San Joaquin County (unemployment rate reported at 9.9% for February 2008) is currently experiencing levels of unemployment almost 74 percent higher than the statewide seasonally adjusted average of 5.7 percent. Even a small increase in the unemployment rate in the City would have a detrimental impact on a county already experiencing the seventeenth highest unemployment rate among California's 58 counties. The projected losses to labor income and total output (similar to gross metropolitan product) for the City as a result of financing either the effluent-to-land disposal or MF/RO treatment alternative would be minor on a percent basis when compared to the total labor income and output of the City, yet the estimated job losses and reduction in local output (see **Table 55**) would produce economic hardship at the household level, with lower income households bearing a larger impact on an annual basis, in relative terms, than wealthier households in the community. Furthermore, the final economic impact of the effluent-to-land disposal alternative would increase significantly if WQCF effluent was required to go through tertiary filtration prior to land application. Likewise, the cost of MF/RO treatment could increase significantly if (1) the brine produced by the process requires additional treatment to remove heavy metals and other contaminants, and/or (2) brine waste requires specialized disposal in some type of hazardous materials containment site. Contingencies of this sort were not considered from an economic perspective by the IMPLAN® model, but certainly could generate additional direct and indirect economic and environmental impacts to be borne by future WQCF ratepayers.

BALANCE OF ENVIRONMENTAL BENEFITS AND SOCIO-ECONOMIC CONSIDERATIONS

State Water Board guidance requires that a complete antidegradation analysis include a balancing of the proposed action against the public interest. The City's approach for compliance with this requirement is to compare the environmental impacts of the proposed project (increase in NPDES-permitted discharge of 7.63[12] MGD (ADWF) tertiary treated effluent) with the environmental and socio-economic impacts of two alternative control measures. These alternatives include (1) effluent-to-land disposal and (2) MF/RO treatment integrated with the proposed project as a means of essentially eliminating the incremental water quality impacts of the proposed tertiary discharge above the already permitted 9.87 MGD (ADWF) level. The socio-economic impacts of the proposed project need not be estimated in the analysis because they form a baseline common to both alternative control measures. Stated differently, the City's proposed Phase IV Expansion Project would be a common element of any future wastewater treatment scenario that could additionally include either effluent-to-land disposal or MF/RO. The estimated one-time fee of approximately $4500 that would be levied against home and business owners in the City's new development areas in order to fund the construction of the Phase IV expansion would be assessed to these future ratepayers regardless of any additional sewer service fees that may be imposed on this group if effluent-to-land disposal or MF/RO was required. The current comparison focuses on the socio-economic impacts and environmental benefits and impacts of the two alternatives relative to the water quality impacts of the proposed project. Additionally, the *no project* alternative is also considered. Based on these comparisons, a project deemed to be consistent with best practicable treatment or control consistent with maximum benefit to the people of the State is identified.

The socio-economic and water quality impacts of the proposed project, the effluent-to-land disposal alternative, and the MF/RO treatment alternative considered in this analysis are compared in **Table 57**. The proposed increase of 7.63 MGD (ADWF) in tertiary treated discharge is projected to have both favorable and unfavorable effects on San Joaquin River water quality downstream of the WQCF outfall depending on the parameter, time of discharge (i.e., season), and ambient flow conditions. The proposed tertiary discharge is projected to have a slight diluting effect, albeit *de minimis*, on some constituents (TSS, total aluminum, dissolved iron, and dissolved manganese (under critical low flows)) in the receiving water, and a slight concentrating effect on other constituents (BOD, ammonia as N (October – May), dissolved arsenic, dissolved copper, total cyanide, MBAS, nitrate as N, nitrite as N, total mercury, and EC (April – August and September – March)). A minor increase in downstream receiving water concentration, relative to its chronic EPA criterion (0.62 mg/L), is projected for ammonia as N during the months of June through September. However, it should be noted that this near-field, seasonally-based, minor increase in ammonia levels will attenuate through natural processes downstream in the receiving water as ammonia is utilized by phytoplankton and other primary producers, thus reducing the pollutant's downstream impact from that projected in the near-field.

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[12] WQCF requested maximum discharge capacity of 17.5 MGD (ADWF) less existing NPDES-permitted discharge of 9.87 MGD (ADWF) results in a net requested increase in discharge capacity of 7.63 MGD (ADWF).

Table 57: Comparison of the Socio-Economic Impacts and Environmental Benefits and Impacts of the Proposed Project and Two Alternative Control Measures

Treatment Level	Monthly Residential Fee Increase	Estimated Annual Loss in Jobs	Treatment and Disposal Process Environmental Impacts
Tertiary Filtration (*proposed project[1]*)	Impact estimated to be one-time fee of approx. $4500 added to price of new home or property lease agreement	Not estimated	**Favorable Impact** ● Slight decrease, albeit *de minimis*, in downstream San Joaquin River concentration for the following parameters: TSS, total aluminum, dissolved iron, and dissolved manganese (under critical low flows). **Unfavorable Impact** ● Slight increase in downstream San Joaquin River concentration and mass for the following parameters: BOD, TSS (*mass only*), total aluminum (*mass only*), ammonia as N (October – May), dissolved arsenic, dissolved copper, total cyanide, dissolved iron (*mass only*), dissolved manganese (*mass only*), MBAS, nitrate as N, nitrite as N, total mercury; slight increase in downstream EC (April – August and September – March). ● Minor increase in downstream San Joaquin River concentration and mass loading for ammonia as N (June – Sept.).
Effluent-to-Land Disposal (*in addition to proposed project[2]*)	$8.26	16.7	**Favorable Impact** ● No change in downstream San Joaquin River water quality above that realized once the WQCF reaches its currently permitted capacity of 9.87 MGD (ADWF). ● Additional water supply source to the region. **Unfavorable Impact** ● Addition of salts to groundwater. ● Groundwater mounding in the area(s) of land application. ● Increase in energy consumption and greenhouse gas emissions due to substantial power requirements of pumping effluent to storage ponds and then to site(s) of land application.

Table 57: Comparison of the Socio-Economic Impacts and Environmental Benefits and Impacts of the Proposed Project and Two Alternative Control Measures (Continued)

Treatment Level	Monthly Residential Fee Increase	Estimated Annual Loss in Jobs	Treatment and Disposal Process Environmental Impacts
Micro-Filtration/ Reverse Osmosis (*in addition to proposed project*[1])	$38.33	77.7	**Favorable Impact** ● No net annual change in downstream San Joaquin River TDS mass loading above the currently permitted 9.87 MGD (ADWF) level. ● An indirect effect of MF/RO treatment is a reduction in mass loadings of metals and nutrients discharged to the San Joaquin River. **Unfavorable Impact** ● Increases in energy consumption and greenhouse gas emissions due to power requirements of MF/RO treatment. ● Disposal of toxic substances and contaminated media resulting from the separation of unwanted pollutants from wastewater. ● Potential need for additional treatment of brine waste to remove heavy metals and other contaminants from the aqueous phase prior to crystallization and disposal of residuals. ● On- or off-site disposal of brine or crystallized residuals. ● Increases in greenhouse gas emissions from truck and rail traffic to dispose of brine or crystallized residuals.

(1) Treatment process upgrades incorporated into the proposed project include nitrification-denitrification, tertiary filtration, and UV disinfection.
(2) The effluent-to-land disposal alternative considered in this analysis includes discharging 9.87 MGD (ADWF) tertiary treated effluent to the San Joaquin River and land applying 3.89 MGD of undisinfected, denitrified, secondary effluent within approximately 10 miles of the WQCF, as well as applying 4.11 MGD of undisinfected, denitrified, secondary effluent to City-owned or leased property near the WQCF.

The implementation of an effluent-to-land disposal operation as a means of limiting the discharge of WQCF effluent to the San Joaquin River at the currently permitted 9.87 MGD (ADWF) level is anticipated to possess both favorable and unfavorable environmental impacts. The favorable impacts include the maintaining of San Joaquin River water quality downstream of the WQCF outfall at the level realized once the WQCF discharges tertiary treated effluent at its permitted capacity of 9.87 MGD (ADWF). To this end, effluent-to-land disposal addresses all incremental changes in downstream San Joaquin River water quality that this report's assessment of projected water quality impacts has identified. A second favorable impact is the additional water supply source to the region that would be provided by the reclaimed water. Unfavorable impacts as a result of land application of undisinfected, denitrified, secondary effluent include addition of salts (as measured by TDS) to groundwater at a concentration greater than the Title 22 Secondary MCL *recommended* level of 500 mg/L, or greater than ambient background quality; groundwater mounding in the area(s) of land application; and increased energy consumption and greenhouse gas emissions due to the substantial power requirements of pumping effluent to storage ponds and then to site(s) of land application.

The implementation of MF/RO as an additional treatment process for tertiary filtered effluent is also projected to have both favorable and unfavorable environmental impacts. The favorable impact is the maintaining of TDS mass loading to the San Joaquin River downstream of the WQCF outfall with an increase of 7.63 MGD (ADWF) tertiary treated effluent discharged to the river. While the MF/RO process would be operated to maintain TDS mass loading to the receiving water at pre-project levels, it would have a favorable indirect impact on downstream water quality through the further reduction of metals and nutrients from the tertiary treated effluent that undergoes MF/RO. This ancillary reduction in tertiary effluent pollutant loading would likewise act to maintain downstream San Joaquin River water quality and mass loading to pre-project levels. It should be noted that the extent of MF/RO treatment considered in this alternatives analysis will not produce demonstrable downstream water quality improvements in the receiving water; the modeled level of MF/RO treatment is designed to maintain downstream TDS mass loading to the San Joaquin River at pre-project levels. Unfavorable impacts of MF/RO treatment stem from the concentration of brine, its potential toxic contaminants and their subsequent removal, ultimate disposal of brine or crystallized residuals, and the substantial energy requirements inherent in this advanced treatment process. Apart from these direct and more obvious effects, MF/RO treatment brings with it the potential to transfer environmental impacts outside of the project area when off-site transport and disposal of residuals create new environmental impacts in other areas of the State.

As directed by the State Water Board's guidelines, the costs of offsetting a proposed project's potential impacts must be estimated and compared to the expected environmental benefits to be gained by maintaining water quality. Within the context of this comparison, it is also appropriate to consider the environmental and socio-economic implications of not going forward with the proposed project; a scenario commonly referred to as the no project alternative. Four scenarios emerge from the current analysis that warrant evaluation: the no project alternative, the effluent-to-land disposal alternative, the MF/RO treatment alternative, and the City's proposed project. As part of this antidegradation analysis, the balance of economic consideration and environmental benefits under each scenario are evaluated herein.

No Project Alternative

If the City chooses not to increase the discharge capacity of the WQCF, the decision would produce unfavorable socio-economic impacts both locally and regionally. From a socio-economic perspective, an increase in WQCF discharge capacity is needed to accommodate continued growth in the City and surrounding communities. Among cities in San Joaquin County with populations greater than 50,000, Manteca is the second fastest growing city and is quickly becoming an urban and economic focal point for the county. Similar to the pace of growth experienced by the City, San Joaquin County is currently ranked as the third fastest growing in California. A restriction in the City's growth due to insufficient wastewater treatment capacity will negatively affect residential development, retail markets, an already high local unemployment rate, and the economic prosperity of San Joaquin County in general. In terms of housing affordability as measured by the Second Quarter 2007 HAI-FTB Index[13] (the most recent data available for San Joaquin County), San Joaquin County possesses more

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[13] The First-Time Buyer Housing Affordability Index (HAI-FTB) describes the percentage of California households that can afford to purchase a median-priced home. Source: California Association of Realtors.

affordable housing than Alameda and Contra Costa counties, but holds slightly less affordable housing than Stanislaus and Sacramento counties. Restricting new development in Manteca will prompt prospective home buyers – as well as retail and commercial development – to look to other cities within the county, or even outside of the county, for affordable housing and business development opportunities. For these reasons, not seeking to increase WQCF discharge capacity runs contrary to the enhancement of the economic health of the City and surrounding communities.

Effluent-to-Land Disposal Alternative

The environmental benefits of effluent-to-land application are proportional to the incremental changes in San Joaquin River water quality that will be offset. Projected increases in downstream receiving water concentrations for a small number of parameters (see **Table 57**) attributable to the proposed 7.63 MGD (ADWF) tertiary discharge are generally estimated to be slight, thus resulting in effluent-to-land disposal acting to offset only slight reductions in San Joaquin River water quality. The minor increase in downstream San Joaquin River concentration, relative to its chronic EPA criterion, projected for ammonia (as nitrogen) during June through September similarly would be offset by effluent-to-land disposal. Land application of undisinfected, denitrified, secondary effluent would also provide an additional water supply source to the region. However, land application of secondary treated effluent would add salts (as measured by TDS) to the groundwater basin underlying the application site(s). Addition of salts to groundwater at a concentration greater than the Title 22 Secondary MCL *recommended* level of 500 mg/L, or greater than ambient background quality, would produce an unfavorable environmental impact, especially in light of the existing, elevated salinity and boron levels found in Central Valley surface waters and groundwater. Effluent-to-land disposal also carries the risk of causing groundwater mounding in the area(s) of land application. A final unfavorable environmental impact of the effluent-to-land disposal alternative is an increase in energy consumption and greenhouse gas emissions due to the substantial power requirements of pumping effluent to storage ponds and then to land application sites.

In regard to socio-economic impacts, the IMPLAN® model estimated that the effluent-to-land disposal alternative would result in the loss of approximately 17 jobs per year during the 20-year life-cycle over which WQCF ratepayers would provide debt service and O&M for this treatment alternative. This level of employment loss is projected to result in an over $580,000 annual labor income loss to the City. These losses would act to further impact a local job market that is currently experiencing an unemployment rate almost 74 percent higher than the statewide average. In total, the cost of effluent-to-land disposal is estimated to result in an annual $3.16 million output loss from the local economy. This suite of impacts is the result of increased sewer fees levied against future ratepayers in new development areas within the WQCF service area and the associated loss of disposal personal income that is no longer available to purchase local goods and services. Furthermore, the *actual* economic impact of effluent-to-land disposal could increase significantly above that estimated in this analysis if the City was required to provide tertiary filtration of its effluent prior to land application. To this end, the environmental and socio-economic costs associated with effluent-to-land disposal are unduly high compared to the water quality benefits that would be achieved through the implementation of this alternative as a means of offsetting the incremental water quality changes projected for the proposed project. For these reasons, it is not in the public interest to require the City to implement effluent-to-land disposal as a means of maintaining existing water quality in the San Joaquin River.

Microfiltration/Reverse Osmosis Treatment Alternative

Similar to the effluent-to-land disposal alternative discussed above, the environmental benefits of MF/RO treatment are proportional to the incremental changes in San Joaquin River water quality that will be offset by the alternative control measure. As stated earlier, the MF/RO treatment alternative would not improve downstream water quality in the San Joaquin River, but merely maintain it at pre-project levels. The projected increases in downstream receiving water concentrations for a small collection of constituents due to the proposed 7.63 MGD (ADWF) increase in tertiary discharge (see **Table 57**) are the exact same as those described for the effluent-to-land disposal alternative. These incremental changes in downstream water quality are estimated to be slight to minor, thus resulting in MF/RO treatment acting to offset only slight to minor reductions in San Joaquin River water quality. The more striking effects of MF/RO treatment are found in the unfavorable environmental impacts inherent in the process resulting from brine concentration, potential need for removal of toxic contaminants, cross-media contamination, brine or crystallized residuals disposal, and the substantial energy requirements of the process with their associated natural resource and air quality impacts.

From a socio-economic perspective, MF/RO treatment is estimated to result in the loss of approximately 78 jobs per year during the 20-year life-cycle over which WQCF ratepayers would provide debt service and O&M for this treatment alternative. This level of employment loss is projected to result in an almost $2.7 million annual labor income loss to the City. These losses would act to further impact a local job market that is currently experiencing an unemployment rate almost 74 percent higher than the statewide average. In total, the cost of MF/RO treatment is estimated to result in an annual $14.67 million output loss from the local economy. This suite of impacts is the result of increased sewer fees levied against future ratepayers in new development areas within the WQCF service area and the associated loss of disposal personal income that is no longer available to purchase local goods and services. Furthermore, the *actual* economic impact of MF/RO treatment could increase significantly above that estimated in this analysis if (1) the brine produced by the process requires additional treatment to remove heavy metals and other contaminants, and/or (2) brine waste requires specialized disposal in some type of hazardous materials containment site. To this end, the environmental and socio-economic costs associated with MF/RO treatment are unduly high compared to the water quality benefits that would be achieved through the implementation of this alternative as a means of offsetting the incremental water quality changes projected for the proposed project. For these reasons, it is not in the public interest to require the City to implement MF/RO treatment of its effluent to maintain existing water quality in the San Joaquin River.

Proposed Project

The water quality impacts analysis conducted earlier in this report shows that WQCF effluent undergoing nitrification-denitrification, tertiary filtration, and UV disinfection will generally result in water of very high quality being discharged by the City into the San Joaquin River. As shown in **Table 57**, *de minimis* decreases in the downstream concentrations of TSS, total aluminum, dissolved iron, dissolved manganese are projected, while slight increases are estimated for BOD, ammonia as N (October – May), dissolved arsenic, dissolved copper, total cyanide, MBAS, nitrate as N, nitrite as N, total mercury, and EC (April – August and September – March). A minor increase in downstream San Joaquin River concentration, relative to its

chronic EPA criterion, is projected for ammonia as N during the months of June through September. However, this near-field, seasonally-based, minor increase in ammonia levels will attenuate through natural processes downstream in the receiving water as ammonia is utilized by phytoplankton and other primary producers, thus reducing the pollutant's downstream impact from that projected in the near-field. More importantly, projected median ammonia concentrations in the San Joaquin River are projected to remain below the more stringent chronic EPA ammonia objective calculated for the river on a year round basis. With the exception of aluminum, median concentrations of modeled constituents are not anticipated to exceed relevant water quality objectives, and on average are estimated to be present at concentrations well below objectives. Any non-negligible near-field thermal impacts resulting from the WQCF's expanded discharge capacity will be mitigated as necessary (e.g., implementation of cooling facilities to lower effluent temperature prior to its discharge into the receiving water) to ensure no non-negligible, adverse thermal effects on fisheries and aquatic resources in the San Joaquin River. The proposed project is not expected to result in far-field exceedances of applicable water quality objectives or standards in the Delta. Additionally, the proposed project will be operated to ensure compliance with the NPDES regulatory program (i.e., future effluent limitations) which will make sure that water quality objectives in the receiving water are met. Furthermore, the reduction in water quality that would result from the proposed project will not unreasonably affect actual or potential beneficial uses.

Project Identified as Providing Maximum Benefit to the State

Considering the 7.63 MGD (ADWF) increase in discharge capacity that is sought relative to the range of year-round flows observed in the San Joaquin River, the difference in downstream pollutant concentrations produced by effluent undergoing tertiary filtration compared to effluent undergoing additional MF/RO treatment is essentially *de minimis* for most constituents once WQCF effluent and receiving water are well-mixed. With regard to the effluent-to-land disposal control measure, the difference in projected downstream receiving water quality when the WQCF is discharging at the currently permitted 9.87 MGD (ADWF) capacity compared to the proposed 17.5 MGD (ADWF) build-out capacity is generally slight, relative to water quality objectives, for most constituents once WQCF effluent and receiving water are well-mixed. Therefore, the critical comparison to be made between alternatives is a balancing of the generally very minor degradation in downstream receiving water quality for a small number of parameters attributable to the discharge of an additional 7.63 MGD (ADWF) tertiary treated effluent against the environmental impacts of effluent-to-land disposal and MF/RO treatment, and the significant socio-economic impacts of these two alternative control measures as estimated by the IMPLAN® model. Based on the balancing of environmental and socio-economic impacts associated with the four scenarios described above, the City has identified the proposed project as the project providing best practicable treatment or control consistent with maximum benefit to the people of the State.

Evaluation of Consistency with Antidegradation Policy

The guidelines set by the State Water Board for the antidegradation analysis (APU 90-004) provide direction on evaluating the WQCF's proposed discharge increase into the San Joaquin River by focusing on whether and the degree that water quality is lowered and by considering whether or not the assumed water quality change is consistent with the maximum benefit to the people of the State. In developing the antidegradation analysis, the San Joaquin River beneficial uses and relevant water quality objectives and commonly used criteria were considered, as well as the environmental and socio-economic costs of wastewater treatment alternatives that would maintain existing water quality in an effort to avoid any potential environmental impacts of the proposed project.

CONSISTENCY WITH ANTIDEGRADATION POLICIES

The proposed project, a 7.63 MGD (ADWF) increase in WQCF discharge capacity with accompanying nitrification-denitrification, tertiary filtration, and UV disinfection treatment to treat the increased flow, is determined to comprise best practicable treatment or control and is consistent with federal and State antidegradation policies for the following reasons:

- The increase in permitted discharge capacity is necessary to accommodate important economic and social development in the City and surrounding communities, and is consistent with the City's General Plan. Failure to approve the increase, or alternatively requiring the City to implement control measures that would maintain existing water quality and mass emissions in the San Joaquin River, would have significant adverse economic and social impacts on the City and surrounding communities and their citizens and businesses.

- The increase will not adversely affect existing or probable beneficial uses of the San Joaquin River, nor will it cause water quality to fall below applicable water quality objectives.

- The increase, while causing slight increases in downstream water quality concentrations for some constituents (BOD, ammonia (October – May), dissolved arsenic, dissolved copper, total cyanide, MBAS, nitrate, nitrite, total mercury, and EC (April – August and September – March)), will produce slight decreases in downstream concentrations for others (TSS, total aluminum, dissolved iron, and dissolved manganese). The proposed increase in discharge capacity is also projected to cause a minor increase in downstream water quality concentrations for ammonia (June through September). Total aluminum currently exceeds its water quality objective in the San Joaquin River upstream of the WQCF outfall.

- The benefits of maintaining existing water quality and mass emissions for the constituents analyzed are not commensurate with the costs of additional treatment. The small decrease in quality with respect to the constituents considered in the analysis is unlikely to affect beneficial uses of the San Joaquin River.

- Based on the above, the requested increase in permitted capacity is consistent with Federal and State antidegradation policies in that the lowering of water quality for several

pollutants is necessary to accommodate important economic or social development, will not unreasonably affect beneficial uses, will not cause further exceedances of applicable water quality objectives, and is consistent with the maximum benefit to the people of the State.

- Based on the above, the requested increase in permitted capacity is consistent with the Porter-Cologne Act in that the resulting water quality will constitute the highest water quality that is reasonable, considering all demands placed on the waters, economic and social considerations, and other public interest factors.

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Appendix A: Streeter-Phelps Dissolved Oxygen Analysis

Using the Streeter-Phelps model, the float time downstream to where the minimum DO will occur can the calculated using the equation as follows (Tchobanoglous and Schroeder, 1985):

$$\Theta_H^* = \begin{cases} \dfrac{1}{k_2 - k} \ln\left[\dfrac{k_2}{k} \left(1 - \dfrac{D_i(k_2 - k)}{kL_i} \right) \right] & \text{if } \dfrac{k_2}{k} \left(1 - \dfrac{D_i(k_2 - k)}{kL_i} \right) > 1 \\ 0 & \text{if } \dfrac{k_2}{k} \left(1 - \dfrac{D_i(k_2 - k)}{kL_i} \right) \leq 1 \end{cases}$$

Where Θ_H^* is the float time in days to the location of minimum DO concentration. The variables D_i and L_i are the combined river and discharge initial DO deficit and ultimate oxygen demand, respectively. The deficit is the difference between the oxygen saturation concentration for the river temperature and the estimated DO concentration of the mixed river and effluent. Values for oxygen saturation are a function of temperature and are from Tchobanoglous and Schroeder (1985). The variables k and k_2 represent the decay rate of BOD constituents and the reaeration rate, respectively.

The BOD decay rate at 20 ºC of 0.10 1/d is the value determined for the San Joaquin River in Chen and Tsai (2002). The temperature dependence of the decay rate is represented as an Arrhenius relationship using the theta value of Chen and Tsai (2002) as follows:

$$k_T = k_{20} \cdot 1.04^{(T-20)}$$

Where k_T is the decay rate at a desired temperature, T (in ºC), given the decay rate at 20 ºC, k_{20}.

The reaeration rate for the San Joaquin River is determined using the empirical formula from Tchobanoglous and Schroeder (1985) as follows:

$$k_2 = \frac{294 \left(D_{L_T} u \right)^{\frac{1}{2}}}{\overline{H}^{\frac{3}{2}}}$$

Where the average depth and cross sectional velocity are represented as $\overline{H}$ and u, respectively. The molecular diffusivity of oxygen at a given temperature, D_{L_T}, is calculated as follows:

$$D_{L_T} = D_{L_{20}} \cdot 1.037^{(T-20)}$$

Where $D_{L_{20}} = 1.760 \cdot 10^{-4}$ m^2/d (Tchobanoglous and Schroeder, 1985).

The bathymetric and flowrate transect data collected for the Thermal Plan Exception analysis (LWA, 2006a) is used to determine relationships between San Joaquin River flowrate and the average depth and cross sectional velocity. The river depth is estimated using a Manning's equation developed using the data collected for the Thermal Plan Exception analysis (LWA, 2006a), and is as follows:

$$\overline{H} = 2.0 \cdot \left(\frac{Q}{1,412} \right)^{\frac{3}{5}}$$

Where $\overline{H}$ is calculated in meters for the desired flowrate, Q expressed in cfs. The average cross sectional velocity is calculated using a nominal channel width of 100 meters as follows:

$$u = \frac{Q \cdot \left(0.02832 \, ^{m^3}\!/_{ft^3}\right)}{100 \cdot \overline{H}}$$

Performing the above calculations allows the calculation of the critical deficit, D_c, as follows:

$$D_c = \begin{cases} D_i & \text{if } \Theta_H^* = 0 \\ \dfrac{k}{k_2} L_i e^{-k\Theta_H^*} & \text{else} \end{cases}$$

The minimum DO is then calculated as follows:

$$DO_{min} = DO_{sat} - D_c$$